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For contents of the Magazine for the month, see pages 2 and 4. Index to Advertisers, pages 41, 43, 44, and 46.

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No. 4. OCTOBER, 1903. Vol. III.

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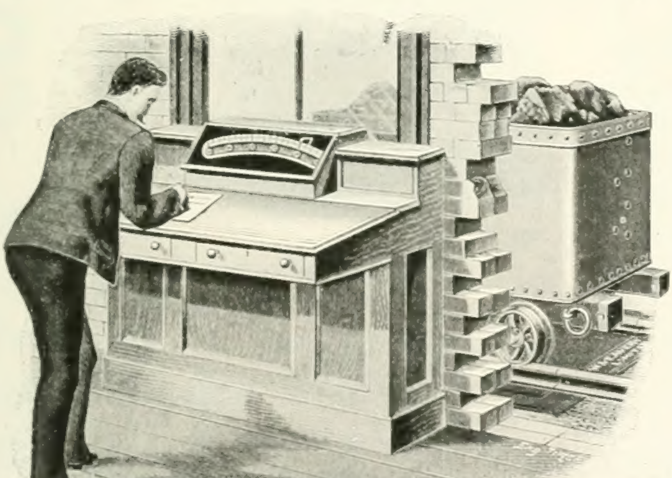

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PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron & Steel, Mining, & Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

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NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 57, 59, 60, 62.*

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

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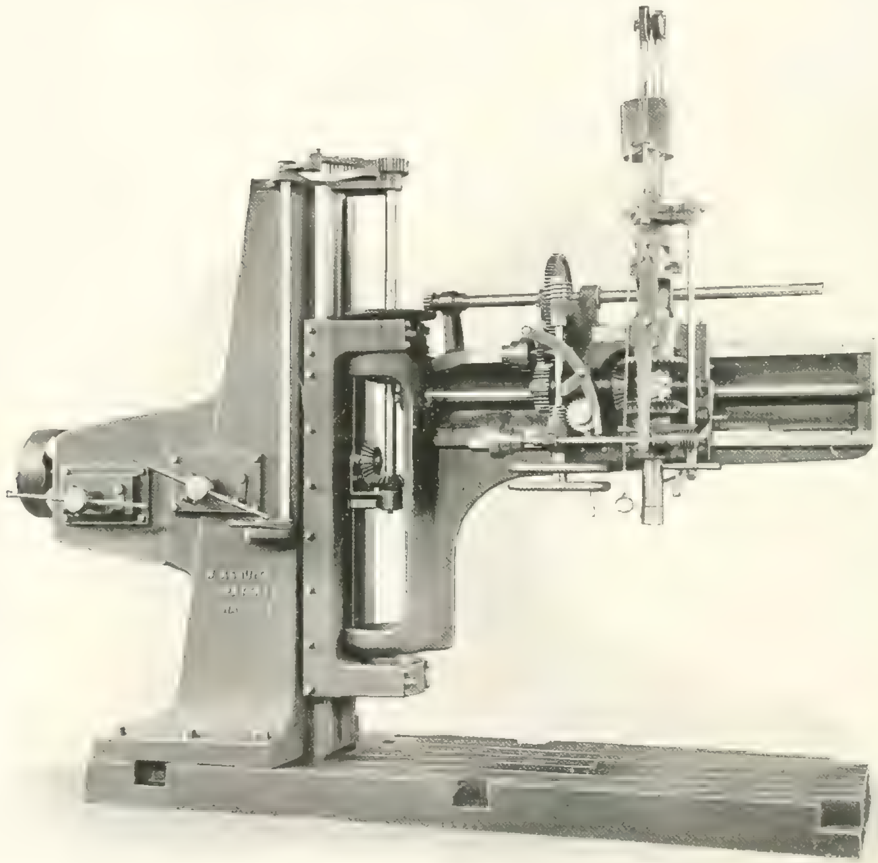

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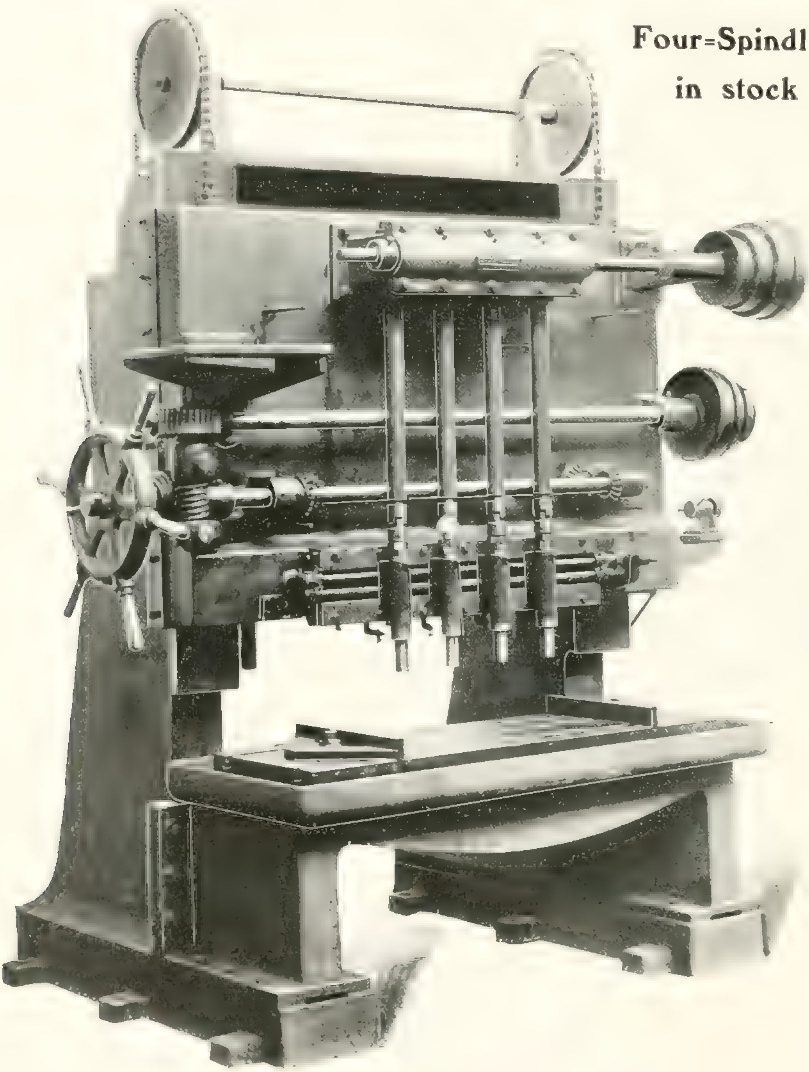

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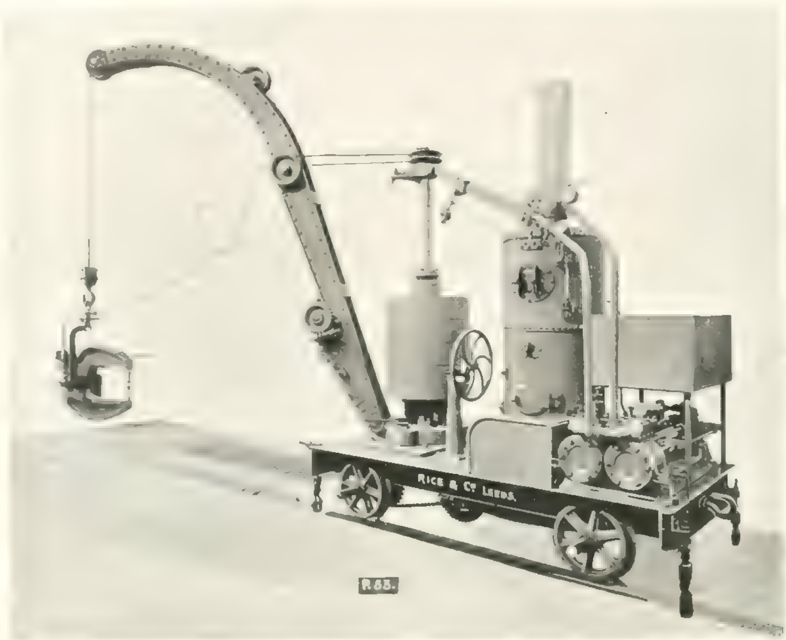

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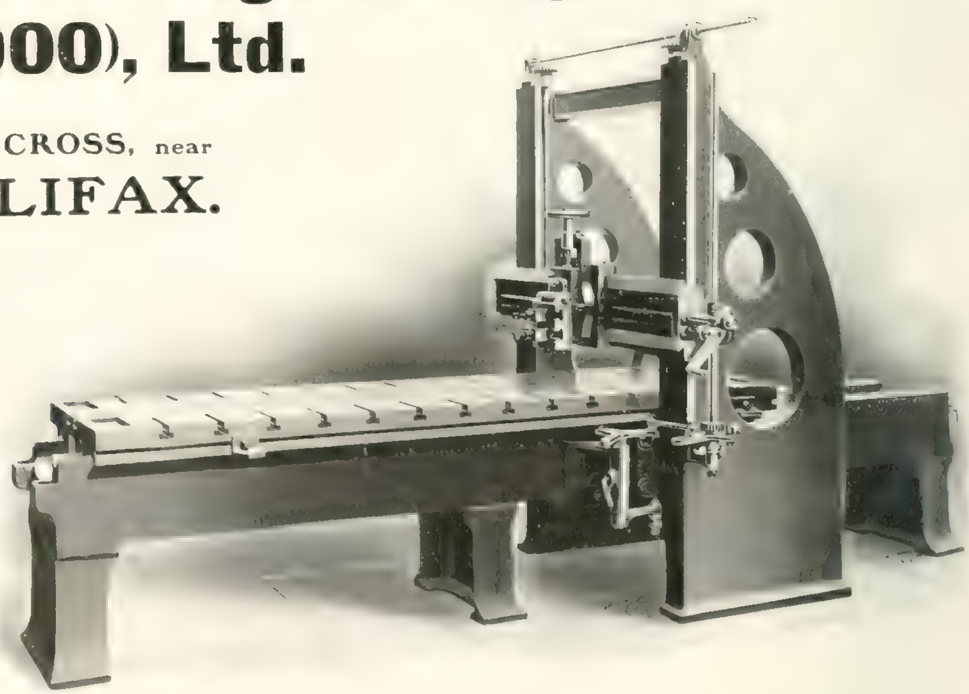

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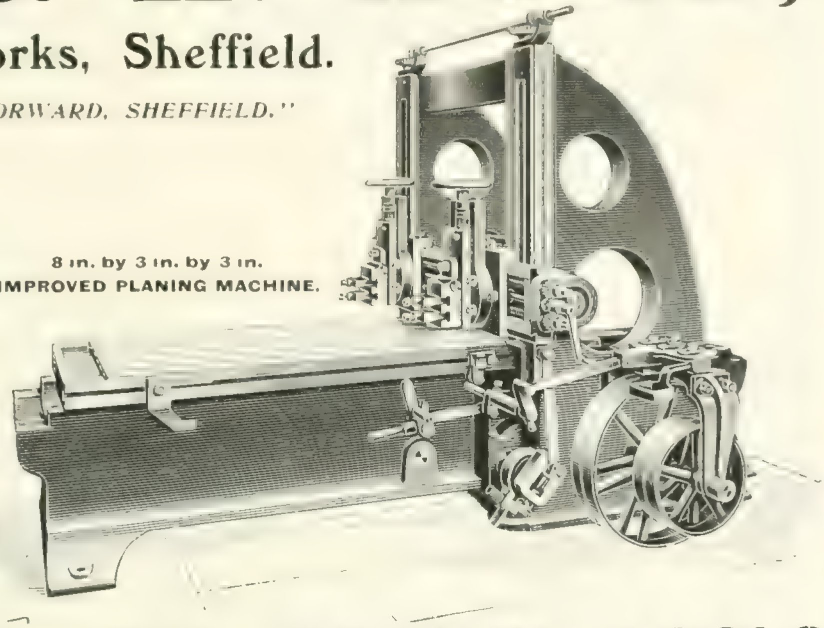

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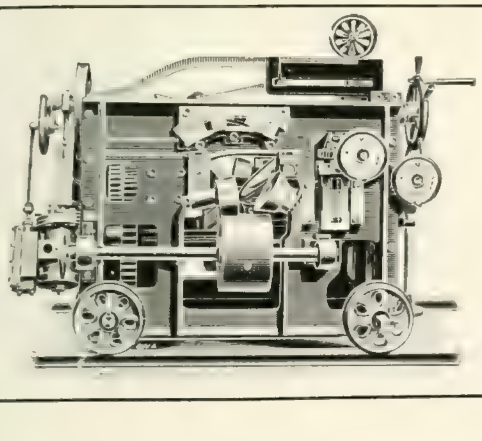

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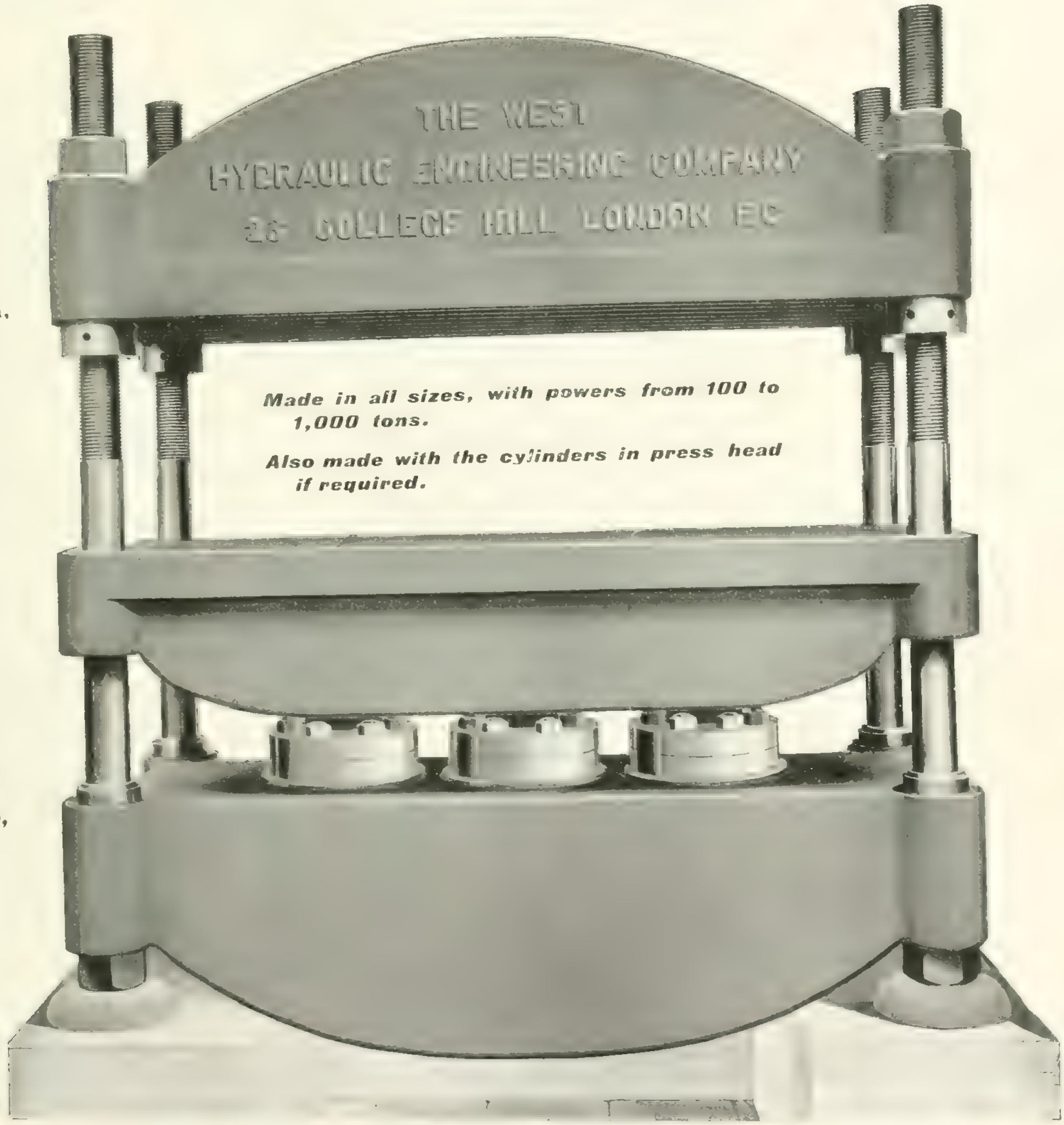

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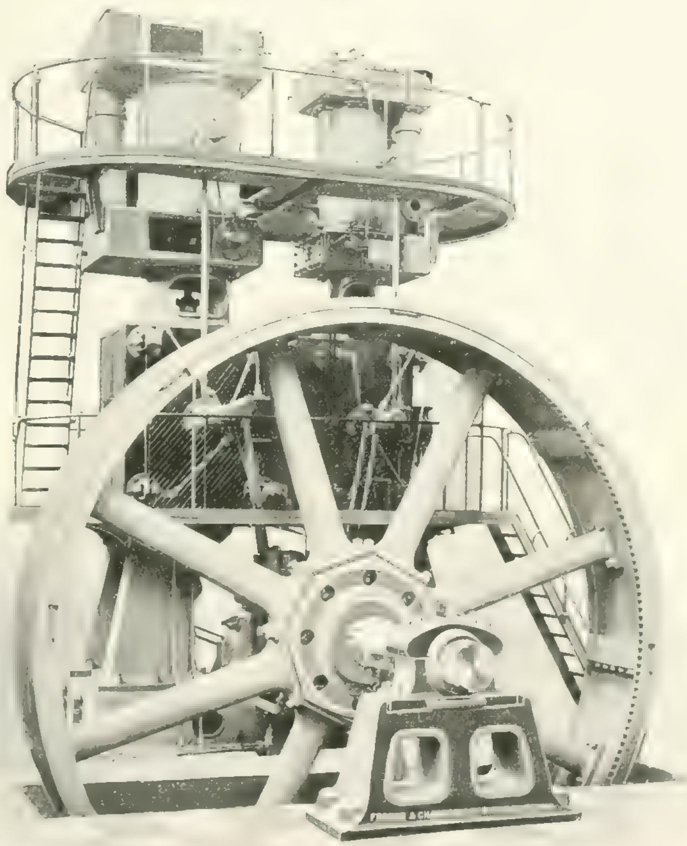

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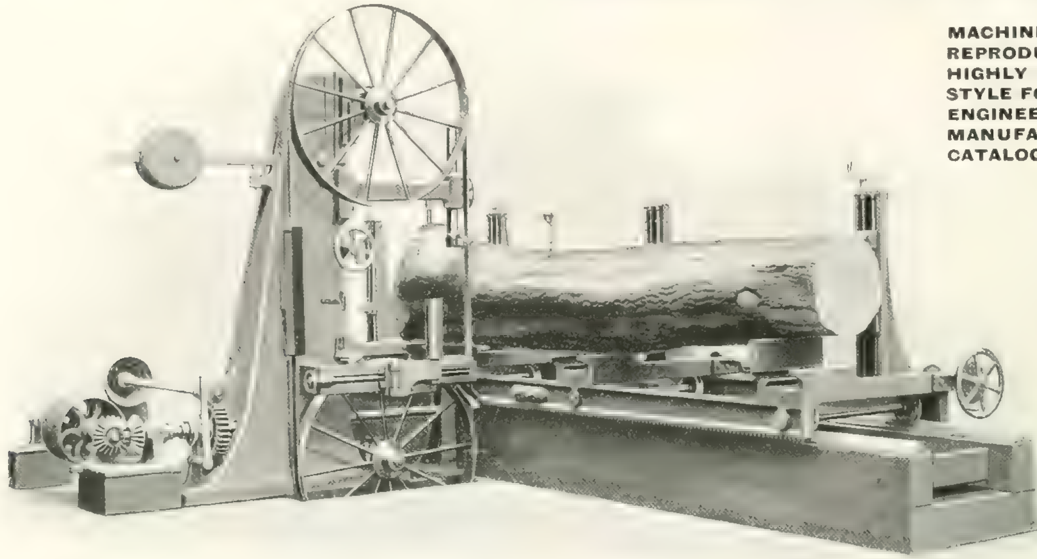

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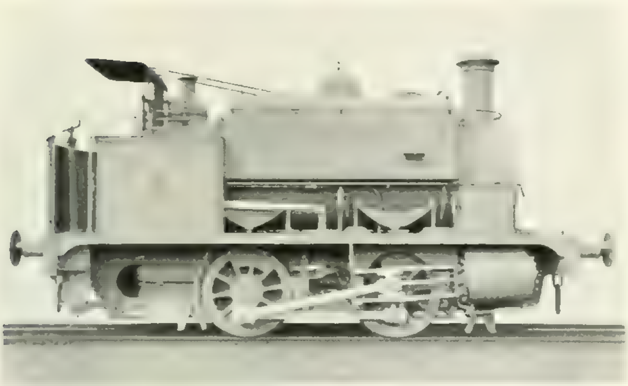

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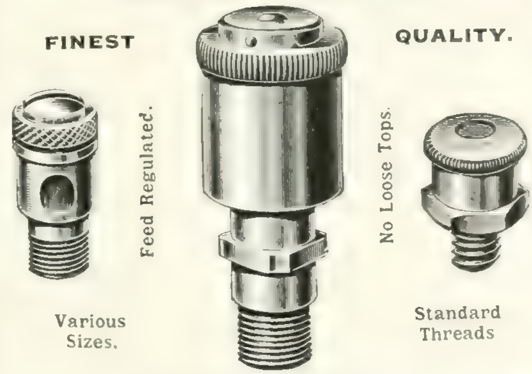

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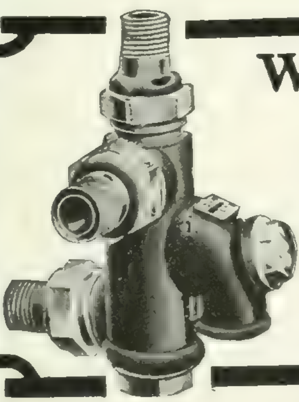

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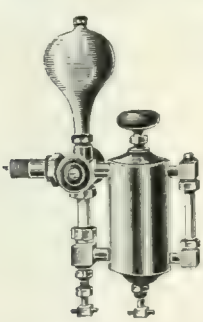

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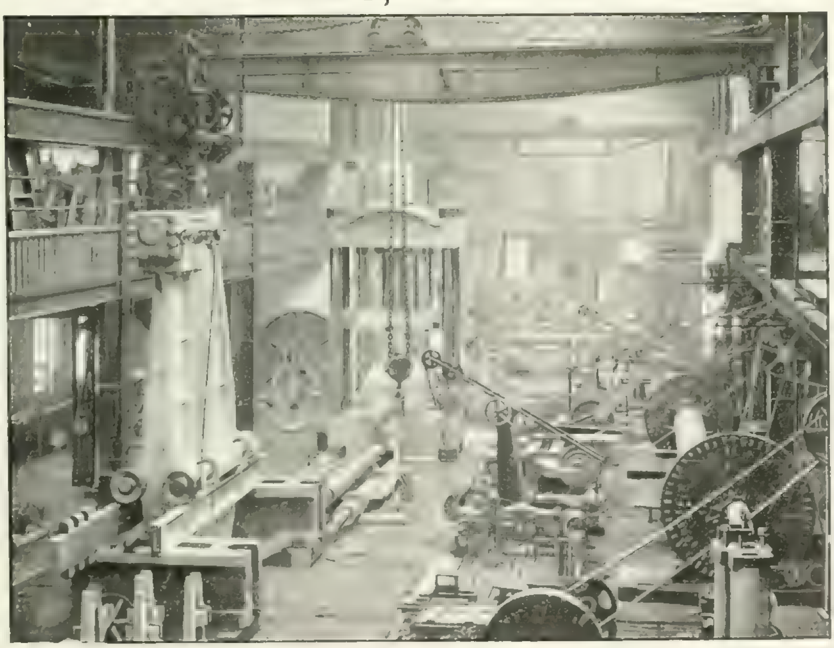

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GENERAL VIEW OF THE SPIER FALLS DAM ON THE HUDSON RIVER.

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PAGE'S MAGAZINE

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VOL. III. LONDON, OCTOBER, 1903. No. 4.

THE TAKASIMA COAL MINES OF NAGASAKI, JAPAN.

BY

E. W. NARDIN.

The illustrations accompanying the article have been forwarded to us by Mr. Oki, the General Manager of the Mines, and serve to emphasise the exceptional conditions under which mining there is carried on. In addition to the usual risks there is the ever present danger of flooding by the ocean. The geological formation is also of special interest.—ED.

THE Takasima Coal Mines comprise four islands near the entrance to Nagasaki Harbour, Japan, and are owned and worked by the Mitsu Bishi Company. There are several unusual features in the occurrence and working of these coal seams, viz. : the steep angle of "dip," the numerous seams of good coal separated by hundreds of feet of sedimentary rocks, the extensive faulting of the strata, and the way in which the coal is won, when so little surface is available for works, and where there is the danger of subsidence of the roof and consequent flooding of the workings by the ocean.

The Islands are named respectively Hasima (Extreme Island), Nakanosima (Middle Island), Takasima (High Island), and Yokosima, and are situated about one mile from the main land. With the exception of Takasima, which is of fair size and has some show of vegetation, they all are simply barren rocky nobs rising out of the ocean.

Hasima has also been partly levelled and in both cases a high stone wall has been built along the water line ; when entering Nagasaki from Shanghai, Hasima looks like a huge grey battleship, the chimney stacks, smoke, etc., adding to the deception.

The country on the main land (to the east) is entirely different from the islands, which appear to be the limit of the sandstone formation in that direction, so that if these beds had not been tilted to such an extent as to bring part of the upper strata above sea level, the coal deposits would probably never have been known. The formation is said to belong to the "Tertiary," and fossils of shells, etc., and leaves are plentiful in the shales.

The main body of rock is a fine grained greyish sandstone, which, near the coal seams, is replaced by shales. A longitudinal section through Hasima, Nakanosima and Takasima shows (by soundings) great depressions between them, and in the workings of all three, these depressions are shown to be due to "faults" (fig. 4).

Between Hasima and Nakanosima the coal seams are broken, and there is now some 20 ft. difference in level. At the north end of Nakanosima, another fault occurs, and also one at the south end of Takasima, and from soundings taken between these two points

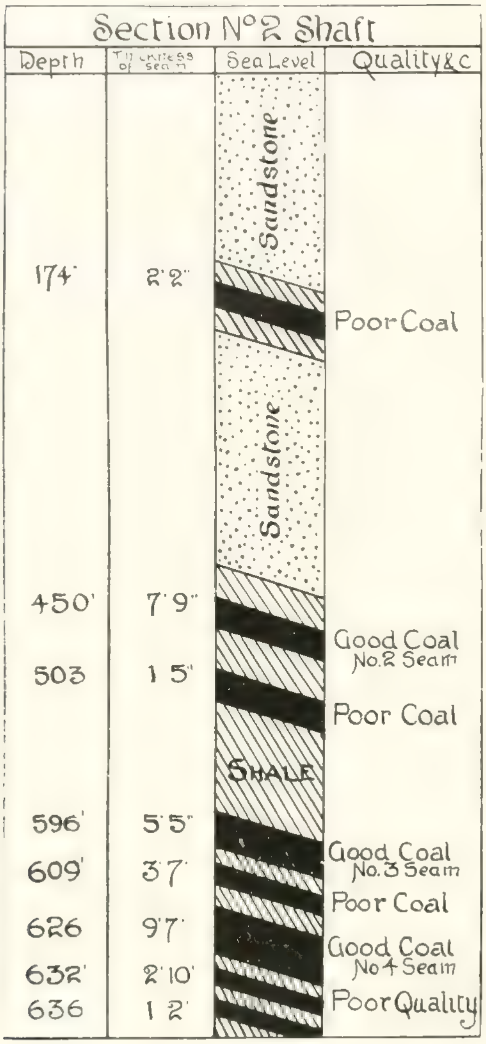


FIG. 3.

it is evident that others exist. The fault at the south end of Takasima is much more extensive than any of the others, the broken portion of the upper seam being found by drills to have been thrown down some 500 ft.

The author examined chiefly the Hasima workings. Here an 8-ft. seam outcropped on the island, and had been worked for some time, but was allowed to fill with water on account of fire. The seams dip west at an angle of 35 deg. to the horizontal, and are thus rather difficult to work. Besides this upper seam, coal is being mined from three others; No. 2, of 7 ft. 9 in. thickness at a depth of 450 ft. from sea level; No. 3, 5 ft. 5 in. thick at 596 ft., and No. 4 of 9 ft. 7 in. thickness (two seams separated by thin seams of shale) at 626 ft.

No. 2 seam is worked by No. 1 shaft, and Nos. 3 and 4 by No. 2 shaft, the workings, airways, etc., of each seam being kept entirely separate. Each shaft is divided, making a return airway 10 ft. by 5 ft. and a double compartment winding-way 10 ft. by 8 ft. Single decked cages carrying two trucks are arranged in these, are hauled by a powerful single drum winding engine, and are fitted with safety catches, detaching hook, etc. Fig. 3 shows a section in No. 2 shaft; it starts from about sea level, so does not include No. 1 seam, which outcrops above it.

No. 2 shaft is sunk 700 ft., a short cross cut is put in to the seam, and then No. 1 level is put in along the "strike"; there are twenty-three of these levels, each 120 ft. apart (on the slope); at every 100 ft. along their course these levels are connected by openings, which are practically "winzes," thus leaving blocks of coal about 100 ft. square. These "winzes" are not at right angles to the levels, *i.e.*, not in the direction of the "dip" of the seam. This is done purposely, to avoid having the haulage gradients too steep, and explains the peculiar diamond shape of the "pillars" shown in the accompanying sketch plan (fig. 1) of the underground workings of the lower seams from No. 2 shaft.

The winding engine on the main incline has double drums, and works a double line of rails, hauling ten trucks, each holding about half ton coal. Branches lead off from each level, and everything is hauled to No. 1 and then run to the shaft. Heavy timbering of all these levels and connections is necessary, as the coal is soft and crumbling and the roof must not be allowed to subside on account of the danger of flooding from the ocean. Very little water has to be contended with, but as the workings are all to the "dip," an excess of pump water is necessary.

The main station is at the bottom of No. 1 shaft, 530 ft. down, and here there are three large Worthington pumps raising the water in one lift; only one is in use, the others being kept ready for an emergency. From the working faces, *i.e.*, the twenty-third level the water is lifted to the sump at the bottom of the shaft in five stages by five sets of Tangye pumps. All these pumps and the winding engines (underground) are supplied with steam from the surface.

Gas is plentiful in some parts of the mine and safety lamps are in use. At each of the shafts, small ventilating fans are working, connected with the up-cast compartment of the shaft. From the pit heads the coal is loaded direct into sailing junks and taken to Nagasaki, where it is stored, and then lightered to the ships as required.

At Takasima, the main seam is being worked from its outcrop by an incline, but the available coal is becoming exhausted and fresh workings must be opened up; a new shaft has therefore been commenced on the south-west corner, and is to be sunk 700 ft. so as to pick up the continuation of the seam on the other side of the fault.

The three sketches (fig. 2) show the outline of the three islands, Takasima, Nakanosima and Hasima,

HASIMA ISLAND.

VIEW OF NEW SHAFTS IN COURSE OF SINKING.

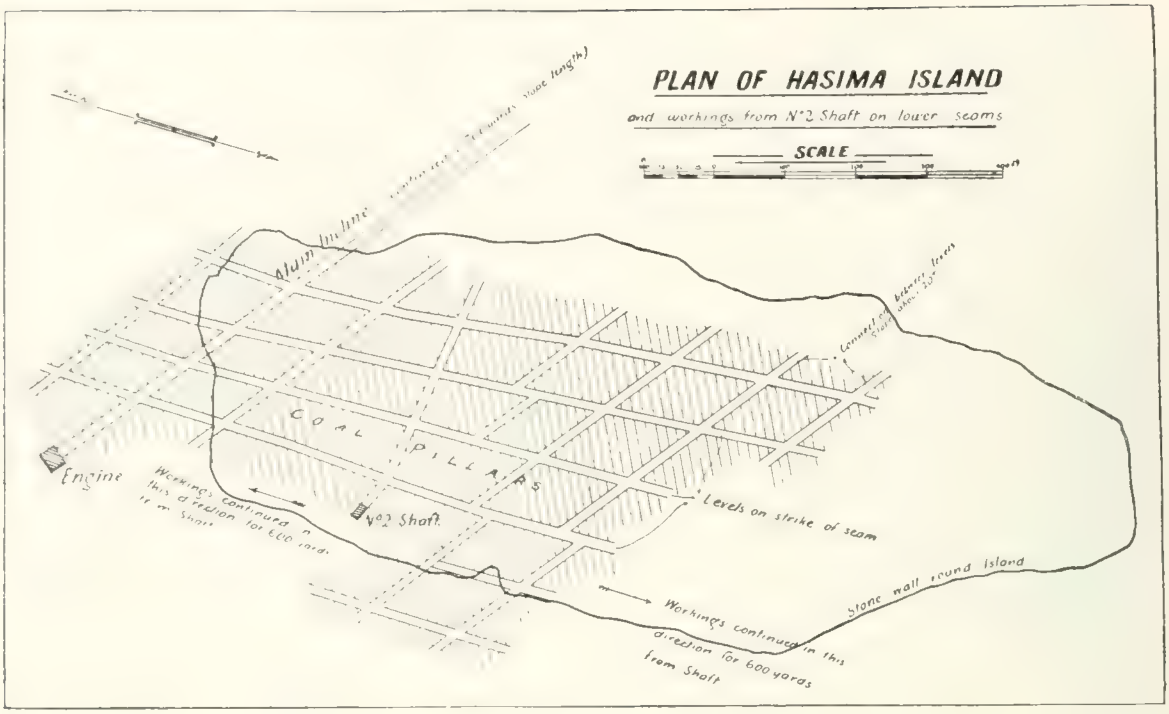


FIG. 1.

FIG. 2. SKETCH PLAN OF HASIMA, NAKANOSIMA, AND TAKASIMA ISLANDS.

ROAD FOR SURFACE TRANSPORTATION BETWEEN THE NEW SHAFTS AND SHIPPING WHARF.

ANOTHER VIEW OF THE NEW SHAFTS.

A PANORAMIC VIEW OF

and the dotted lines show the extent of the workings at the present time. Altogether on the three islands, three thousand miners and two thousand surface hands are employed.

The following is a report on some Japanese coals, made to the Mitsu Bishi, in 1891, by Edward Slivers, F.A.S., F.I.C., F.C.S.

NO. 1, KOGAYAMA.

Moderately hard and lustrous, with rectangular clean fracture, powder almost black. Free burning, slightly caking, long flame.

Specific gravity	1·283	
Moisture in air-dry coal ..	4·3	per cent.
Volatile matter, less moisture	34·2	
Ash, pale and soft	3·3	
Coke (less ash) compact, but not very coherent .. .	58·2	
Sulphur .. .	0·75	

NO. 2, NAMAZUTA.

General character like that of No. 1. Fracture more even, not quite so hard.

Specific gravity .	1·290	
Moisture in air-dry coal	3·1	per cent.
Volatile matter, less moisture	35·7	
Ash, pale soft	4·73	
Coke (less ash) like No. 1	56·5	
Sulphur . ..	0·61	

NO. 3, SHINNYU.

Moderately hard, conchoidal or hackly in fracture, lustre resinous or brighter, otherwise like No. 1.

Specific gravity	1·290	
Moisture in air-dry coal ..	3·4	per cent.
Volatile matter, less moisture	37·1	..
Ash, pale soft	6·25	.
Coke (less ash) like No. 1 ..	53·3	
Sulphur	0·48	

NO. 4, NAKANOSIMA.

Very soft, lustre resinous, fracture hackly, powder brown. Highly bituminous fat coal, swelling enormously, long flame.

Specific gravity	1·236	
Moisture in air-dry coal ..	1·6	per cent.
Volatile matter, less moisture	37·7	.
Ash, pale soft	3·35	
Coke (less ash) soft and spongy	57·3	.
Sulphur	0·31	..

NO. 5, TAKASIMA (NO. 1 PIT).

In general character like No. 1.

Specific gravity	1·252	
Moisture in air-dry coal ..	1·8	per cent.
Volatile matter, less moisture	35·5	.
Ash, pale and soft	6·35	.
Coke (less ash) like No. 4 ..	56·4	
Sulphur	0·72	.

NO. 6, HYAKUMANSAKI (TAKASIMA).

In general character like No. 4.

Specific gravity	1·258	
Moisture in air-dry coal ..	1·7	per cent.
Volatile matter, less moisture	39·0	.
Ash, pale soft	7·95	
Coke (less ash) like No. 4 ..	51·4	.
Sulphur	0·81	..

All the above coals have high heating power.

TAKASIMA ISLAND.

Variety of Coal.	Sp. Gr.	Moisture.	Vol. Mat.	Ash.	Coke.	Sulphur
No. 1 ...	1·285	4·3	34·2	3·3	58·5	0·75
No. 2	1·260	3·1	35·7	4·75	56·5	0·61
No. 3	1·200	3·4	37·1	6·25	53·3	0·48
No. 4 ...	1·236	1·6	37·7	3·35	57·3	0·31
No. 5	1·252	1·8	35·5	6·35	56·4	0·72
No. 6 ...	1·258	1·7	39·0	7·05	51·4	0·81
Takasima New 8 ft. seam ...	—	1·22	39·88	3·40	55·50	0·25

Coals Nos. 1, 2, and 3.

These coals are of very good quality, giving a long flame and a solid free burning body on the bars, and, having very little sulphur and not much ash, they will be excellent steam coals, only requiring a little care in stoking and a sufficient flame space in the boilers in order to give but little smoke.

They will also be excellent for gas making, and particularly so because of the little sulphur they contain. They can also be made into a compact coke, which, however, may be deficient in hardness.

Coals Nos. 4, 5, and 6.

These coals also have the advantage of having very little sulphur and not much ash and of yielding a long rich flame; but they soften and swell and cake so as to somewhat impede the draught through the bars. They are also very soft coals to handle, but with management, they can prove good serviceable steam coals. They are also good gas coals, but their coke is soft and spongy. A mixture of the two classes of coals might furnish excellent coke.

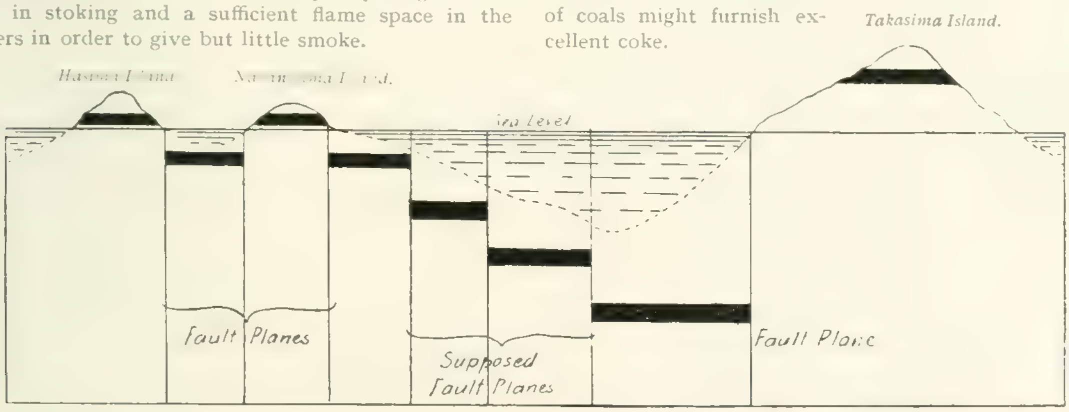


FIG. 4. SKETCH SHOWING LONGITUDINAL SECTION ON A NORTH AND SOUTH LINE.

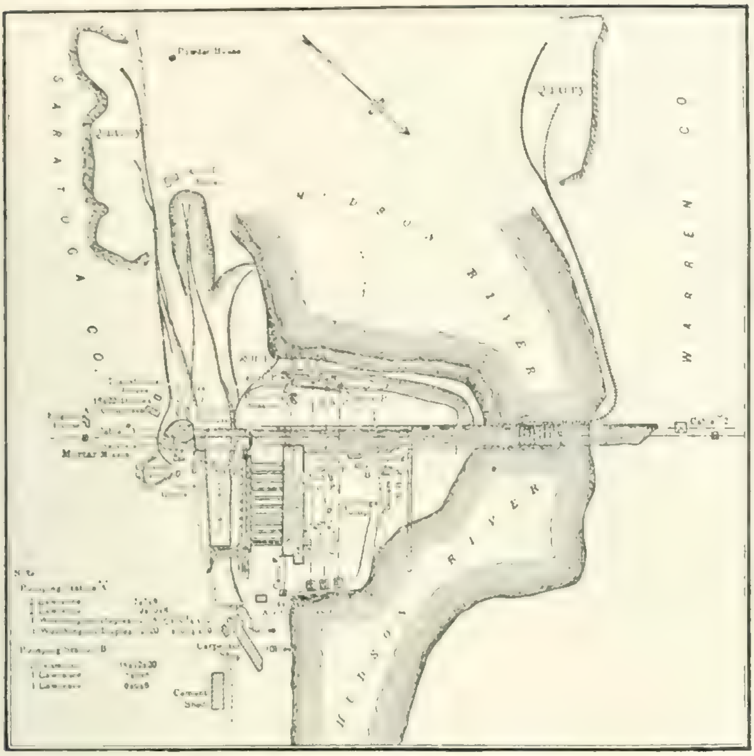
AN EARLY STAGE OF THE EXCAVATIONS IN 1901.

THE SPIER FALLS DAM.

The Spier Falls dam of the Hudson River Water Power Company, one of the greatest enterprises of the kind in the world, has established a new record for rapid dam construction. A commencement was made three years ago in June, 1900, and the masonry work is now practically complete. For the following facts and illustrations we are indebted to Mr. Charles E. Parsons (engineer), and to the *Engineering News*.—Ed.

THE Spier Falls Dam is located at a point on the Hudson River about nine miles south-west of Glens Falls, where the building of the dam will create a reservoir five miles long, one-third of a mile wide, giving an 80-ft. head of water. Ten turbines, each capable of developing 5,000 h.p., will drive dynamos feeding electricity to Saratoga, Schenectady, Glens Falls, Troy and Albany. Even at times of low water the minimum power development will be 20,000 h.p. The location of the dam and the plant used in its construction are shown on plan. The operations have included the excavation of some 270,000 cubic yards of rock and earth, and the building of 180,000 cubic yards of masonry, besides the construction of enormous cofferdams. At times more than 1,500 men have been engaged, the work proceeding day and night.

The Spier Falls Dam.



GENERAL PLAN OF THE WORKS.

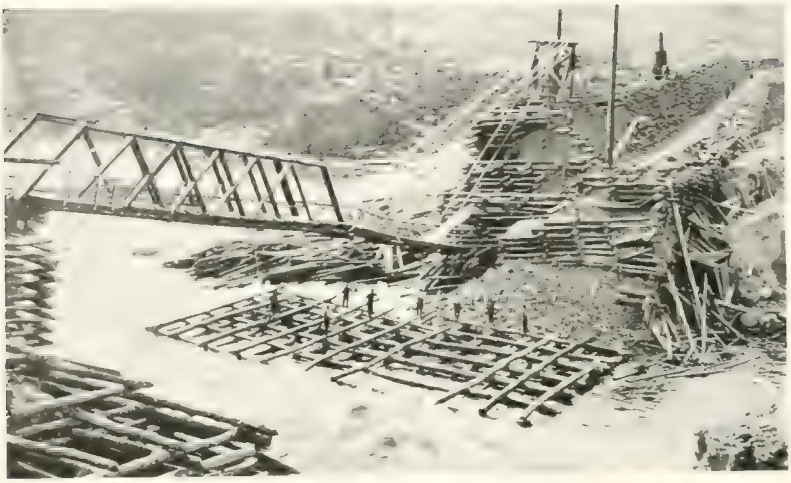
THE COFFERDAMS.

One of the most interesting features of this great work is the cofferdamming. Since the bed of the river at Spier Falls was a mass of boulders, underlaid in many places by cemented gravel or hardpan, cofferdams of log cribwork loaded with rock were necessarily adopted. After the cribwork of the main cofferdam was in place a heavy fill of broken rock was made along its upper face, and regarding this rock-fill, Chief Engineer Charles E. Parsons says it was the most essential feature of the work, for it would have been almost impossible to have stopped some of the larger leaks without it. When a leak started, these stones would settle and lodge, and it was then an easy matter to hold the outer gravel-fill.

In making this rock-fill, the largest stones were placed against the cribwork, and then covered with rubbish from the quarries. The gravel for the final layer was excavated with a steam shovel and delivered by cars hauled by "dinkeys," so that after two months' work with the steam shovel the main part of the cofferdam was practically tight. This main cofferdam at its greatest cross-section is 250 ft. wide at its base, 80 ft. at its top, and is 90 ft. high. It is about 600 ft. long, and its average dimensions are about 150 ft. wide at base, 25 ft. wide at top, and 60 ft. high. After the completion of this main cofferdam a 6-in. centrifugal pump handled the entire leakage, which indicates what a substantial structure it is.

The river having been diverted by the cofferdam just described now flowed along its left or north bank. Originally it flowed straight through the site of the cofferdam, and where the river channel now is, along the north bank, there was a bed of gravel and boulders 35 ft. deep. The spillway masonry was built first on the north side of the river, four archways, 7 ft. by 10 ft., being left to carry the river. These archways are 35 ft. above the old river bed, and will eventually be closed with sliding timber gates, and permanently filled in with masonry. In constructing the main cofferdam, a gap was left about 100 ft. wide, the gap being bridged so that stone and gravel could be hauled across. The spring freshets in 1901 undermined the north side of this gap, and dug deep into the old river channel, making closing of the gap more difficult. To effect this closing, a heavy timber crib was begun on the north side of the opening, and was sunk to the bottom by using green hardwood timber, wire cables being used to anchor it during construction. It was then partly filled with stone and built up 6 ft. above the water. In like manner a crib was built out from the south side of the gap, until a small wedge-shaped gap was left 20 ft. wide at the upstream face, and 6 ft. wide at the downstream face. A crib was then made to close this gap, and was suspended by hemp ropes until it was built up to a height of 30 ft. above the water, when the ropes were cut and the wedge dropped into place. After these gap or foundation cribs were in place, they were filled with stone until the water rose nearly to the top. A sluiceway 20 ft. wide was then built to carry the river over the foundation cribs, and more stone was thrown into the cribs to raise the water until it flowed through the sluiceway. Another sluiceway was then built, six feet higher than the first, and the water diverted to it by building up the crib and finally closing the front of the first sluiceway with 6-in. plank. In this manner the water was raised, step by step, 35 ft. until it found an outlet through the temporary archways in the spillway. The method of thoroughly stopping leakage by rock and gravel filling above the cribwork has already been described.

As is inevitable on work of this character and magnitude, delays and damage from floods occurred, but each new problem was met and solved in a manner most creditable to the skill and pluck of the engineer in charge—Mr. Charles E. Parsons.



METHOD OF BUILDING COFFERDAM.

it really is a rubble with concrete for mortar. The percentage of concrete so used has not yet been calculated, but it will probably be about 30 per cent. of the whole dam. The labour cost of laying this masonry, not including the cost of mixing the concrete, has been about 60 cents per cubic yard. There are two labourers employed to every mason, their wages being respectively 15 and 35 cents an hour. It will be noted that the use of concrete not only effects a saving in the labour item, but it effects a saving in the labour item by reducing the number of high-priced masons.

For dam work this type of masonry has evidently the great merit of comparative cheapness, while at the same time it is fully as effective as any other type of masonry that might be used. Where stone is tough and comes out in such masses as this does, it would be simply folly to reduce it all to concrete size. In these days of concrete it is the part of wisdom not to ignore the fact that rubble masonry in massive structures, and particularly rubble with concrete as mortar, will usually be found cheapest.

The face stones in the river section, on the downstream face, are laid with their beds inclined to the horizon, and in the laying of this work the engineer has again shown his good judgment by laying the stones dry, and grouting the joints. The grout is

BAILING AND DRAINING.

The pumping plant consisted of five 8-in. and three 6-in. Lawrence centrifugal pumps, two 4-in. pressure-pumps, and two compound 8-in. Worthington pumps, and at times this plant was strained to its limit to lower the water enough to locate the larger leaks. After the leaks were stopped four pumps served. The water leaking through the upper or main cofferdam is raised 80 ft. in two lifts by 8-in. centrifugals. The total leakage from all the cofferdams is about four million gallons (534,140 cubic feet) each twenty-four hours.

MASONRY.

The rough granite blocks forming the core of the dam are quarried a short distance above the dam and delivered to the transverse cableways by rail. The powder used is 60 per cent. dynamite. The most regular stones are selected for the faces of the river section of the dam, but even on them there is very little work expended in dressing, while the backing is not dressed at all. The mortar in the backing is a 1-3-5 concrete, the cements used being Ironclad and Atlas. This use of concrete instead of ordinary mortar between the stones obviously effects a decided saving in the cement item without impairing the solidity of the masonry; and to further reduce the cement per yard of masonry, large spalls are also used in filling the vertical joints between the huge blocks of stone. This class of masonry may be called rubble-concrete;

PART OF DERRICK AND CABLEWAY PLANT.

The Spier Falls Dam.

[illegible] in quite thick, a steel rod being used to force it down to the bottom of the joints, and insure against a clogging that might prevent the full bedding of the stone in mortar.

The face stones on the overflow section were imported several miles by rail and boat, for it was found very expensive to dress the local stone to the ½-in. joints used on this part of the masonry. As a matter of fact, it cost $24 a cubic yard to quarry, dress, deliver and lay the local stone in the face, as against $15 for the imported stone.

INTAKE PIPES LEADING TO THE WATER WHEELS.

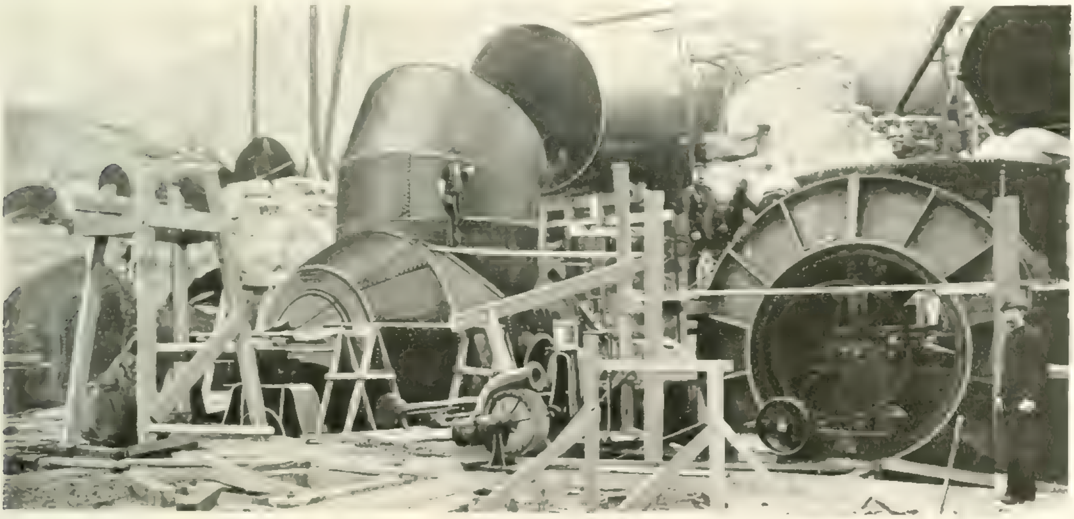
DERRICKS AND CABLEWAYS.

Seven Lidgerwood cableways are in use, three parallel with and four perpendicular to the dam. Two of these are the longest cableways ever used, one being 2,140 ft. between towers and the other being 1,660 ft. The main cable on the first named is 2¾ in. diameter, and the cables of the others are 2 in. to 2¼ in. The four transverse cableways are each 700 ft. long.

For handling the stone after it has been delivered by the cableways, stiff-leg derricks are used. As the dam increases in height, these derricks are raised to successively higher platforms anchored to the sloping face of the dam. The rear stiff-legs have been lengthened by splicing until now there is one derrick with a rear leg 113 ft. long. Guy-derricks could not be used because the guy lines would interfere with handling the cableway skips.

CONCRETE.

The crushing and mixing plant is located so that by means of a circular car track the mixed concrete is delivered in buckets on cars to the long cableways. Three Ransom mixers, each of 1 cubic yard capacity, are giving excellent service. Two of the mixers are running on concrete, and the third on mortar. Each concrete mixer turns out about 200 batches every ten hours, there being 23 cubic feet of concrete to the batch. The concrete is discharged into an iron bucket holding 2 cubic yards. The bucket is hauled away on a car by a mule, and delivered to the cableway. All the materials are fed by gravity into the mixer.



THE 5000-H.P. WHEELS IN COURSE OF ERECTION.

The sand is delivered from the pit in dump cars, and is raised by a bucket elevator. A rotary screen takes the pebbles out, and to prevent clogging of the screen it has been found very advantageous to fasten long baffle plates to the inner side of the rotary screen. These plates carry the sand around and drop it when a certain inclination is reached. The sand is discharged from the screen into a bin, and fed by means of a chute controlled by gates. The cement is raised in bags by means of a belt conveyer.

The stone from the quarry is fed into a No. [illegible] Gates crusher, having a capacity of fifty tons per hour; and is elevated and screened. All pieces larger than 3 in. diameter are returned in a chute to a No. 2 Climax jaw crusher. The pebbles from the sand are also delivered by a chute to the jaw crusher. The crushed stone and water are first admitted to the mixer, then the sand and cement, and in less than two minutes a perfect mixture is secured. There are about thirty men engaged in and about the mixing plant, including men feeding the crusher, feeding the materials from bins into the mixers, attending to mixing and dumping, loading cement on to belt elevator, men opening cement bags, driving mules and switching cars, and others performing sundry duties.

A large part of the concrete is now being used in building the walls and floors of the power-house. In the foundation walls the concrete is deposited very wet, and a layer of stone, or large spalls, is bedded into each layer of concrete, the men jumping on each stone to push it down into the soft concrete. Spades are used to force all stone back from the face of the walls so that there will be 2 in. or 3 in. of pure mortar on the face.

HAULING BY WAGONS.

Over sandy earth roads from Glens Falls all the cement, coal and machinery has been hauled in wagons, a distance of nine miles. One round trip a day is made, teamsters being paid by the ton of load hauled. The loads hauled by each team have ranged from 3,500 lb. to 4,500 lb., and this despite the steep pull at the end.

One load of twenty-eight tons was drawn on rollers running on timbers, much as in house moving, and twelve teams were required to move it, taking nine days to travel the nine miles.

POWER-HOUSE.

The power-house will be divided into three sections: (1) the wheel room; (2) the generator room, and (3) the transformer and switchboard room. In the wheel room there will be ten pairs of turbines, each having a capacity of 5,000 h.p., under an 80 ft. head. The wheels are set 12 ft. above the level of the tail race water, and each pair has one draft tube. The generator room will contain ten 3,350 h.p, three-phase, 2,000-volt, 40-cycle, direct-connected general electric generators, running at 240 revolutions per minute. There will also be three 265 h.p. exciters, each direct connected to its own water wheel. In the transformer room there will be thirty 1,100 h.p., high-potential transformers, beside motors and blowers, and the high and low-potential switchboards.

The five-feeder circuits have a capacity of 50,000 h.p., and the longest circuit will be forty-two miles.

THE REVISION
OF A
DRAWING OFFICE.

BY

W. STANLEY BOTT.*

Mr. Bott, in the course of the following paper, offers some hints which should be useful to the drawing office, even although a complete revision may not be in contemplation.—Ed.

THE exigencies of modern manufacturing competition in the engineering trade have caused many firms to remove from London into the country, to enable them to build new works, arranged for more economical production. We shall consider in the following pages some of the alterations made necessary in the drawing office system of one of these firms, by the improved conditions of manufacture, in the hope that the experience gained may be useful to others about to undergo similar changes.

FIG. 1. SHOP ORDER SHEET.

METHODS PREVIOUSLY IN VOGUE.

Before proceeding to describe the new drawing office arrangements dealt with in the following paper, it will be advisable to give a short description of the methods in vogue before they were inaugurated :—

(1.) In the first place drawings were made in various sizes, up to antiquarian, double elephant being the most usual.

(2.) Forgings were detailed full size, but castings were very seldom drawn out in detail.

(3.) Drawings were numbered in connection with the number of the drawer in which they were kept ; this number was never made use of for reference, and did not appear on the pieces.

(4.) Tracings were used in the works, no blue-printing apparatus being available.

(5.) No pattern numbers appeared on any drawings, and very few pieces had names.

(6.) Tracings sent outside the works were entered in a tracing book and given a number, the information for whom and to whom they were sent being also noted. This number had no relation to the drawing, and did not appear on it.

(7.) Certain machine parts, such as cutters and tools, etc., more particularly those which had to be obtained from the country, were given a detail number, one or more detail numbers being on one drawing.

(8.) Hand sketches were sometimes made, but no copy was kept in the office.

(9.) Drawings were kept in drawers numbered 1 to 79 under the class of machine to which they belonged, and the drawers were arranged against one wall of the drawing office from floor to ceiling.

REVISING A DRAWING OFFICE SYSTEM.

In the new works the drawing office has about two and a half times the floor area of the old, is lighted with

* A paper included in the proceedings of the Institution of Mechanical Engineers.

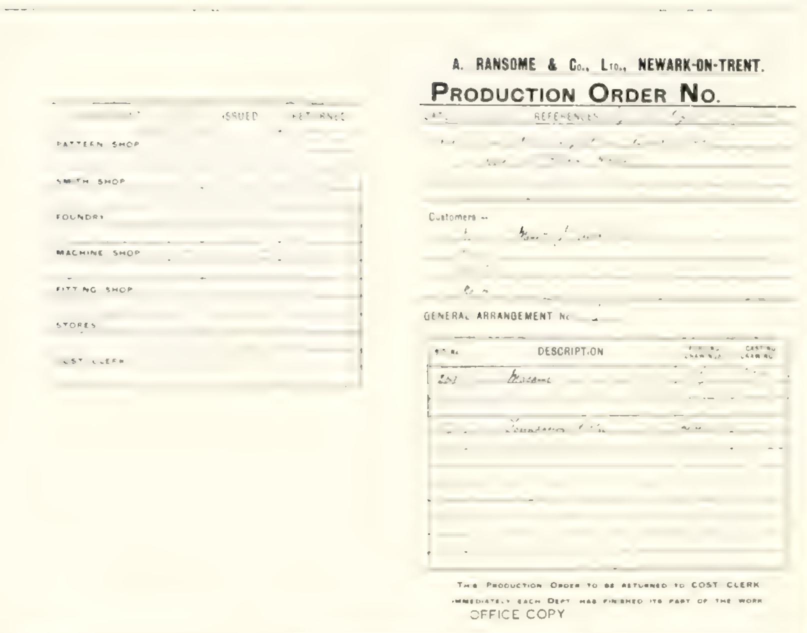


FIG. 2. PRODUCTION ORDER COVER TO HOLD THE SHOP ORDER SHEETS.
Scale about one-fourth originals.

The third point is the office copy. The office copy drawing in all cases is a tracing, generally made on cloth, but sometimes tracing paper is used for a special job. All drawings referred to hereafter are office copy drawings. These have an additional border line and margin, at the right-hand end, the latter bearing the words "Office Copy" as well as the initials of the tracer and of the draughtsman who checked the figures. This margin allows these particulars to be cut off any prints made from a tracing without departing from the regular sizes. Drawings are all numbered in the left-hand bottom corner and titled in the right-hand bottom corner; the number of the drawer in which it is to be put away appearing outside the border line, in the right-hand top corner. In the right-hand bottom

a [illegible] light, the artificial light being two inverted arc lights supplemented by six incandescent lights.

In proceeding to revise the system just described, three points were seen to be imperative, namely: (1) Every drawing must have a number and be known by that number; (2) All drawings must be made to standard sizes, and of as few sizes as possible; (3) A copy of every drawing must remain in the office, and be known as the office copy.

To consider the first of these points, the number, it was seen that a simple number would not do, because there were already in existence some hundreds of cutters, tools, etc., bearing detail numbers, and to avoid confusion it was decided to number the drawings in the following manner: Below the drawing number proper a line was ruled, and underneath this a number was put to represent the year thus [illegible] represents [illegible]. [illegible] year the top number will commence at 1, and the lower advance with the years. The author believes that a similar system to this is in use by Messrs. J. Simpson and Co., of Pimlico. This method was made easier at starting, owing to the change taking place at the commencement of the century; and no doubt before three figures are introduced for the years a better method will be devised.

[illegible] decided upon as being most convenient for general use, this size allowing a fair margin on a double elephant sheet; any smaller drawings are made 24 in. by 18 in., 18 in. by 12 in., or 12 in. by 9 in., these sizes referring to border lines.

corner also appears the working or shop order number, and the number of sets required for that working number and the date, the quantities in all cases on a drawing being for one set only.

Having settled these three important points, the "number," "size," and "office copy," the next thing to consider was the method of keeping them. In the old office the drawers near the ceiling were impossible to get at without the aid of a pair of tall steps, which was very inconvenient. Therefore it was decided to keep all drawings in the new offices below the level of the tables. The method adopted was this.

DRAWER CASES.

The drawers, double elephant size, were made up in cases of ten, each case being a complete thing in itself. Each case contains as nearly as possible all the drawings for one class of machinery, so that in the future, when the business expands, any case can be moved to another office if necessary without disturbing any other class, and if one draughtsman is working on that class only, he can have the case under his table, and all the drawings immediately to hand; this will be an immense advantage as specialisation progresses. Each drawer in the centre of the front bears a label stating its contents; the top drawer of each block bears in large letters the group or class of machinery in that block.

METHOD OF MAKING DRAWINGS.

Having decided the size and form of drawings the author will proceed to describe the method of making

The Revision of a Drawing Office.

FIG. 5.
Scale about one-third originals.

them. All drawings are made in pencil on a cheap cartridge paper and then traced; the drawing paper is used on both sides and ultimately is either used for envelopes or destroyed. The use of these envelopes is described later. When tracings have been checked, they become office copy drawings, and they are then blue-printed. These prints when in the shop are kept on boards, of which there are three sizes, specially constructed to allow the prints to be readily mounted or removed from them. Each department has a supply of these boards.

DIVISION OF PRODUCTION ORDER.

The route of an order through the drawing office into the works will now be described. An order, called a production order and bearing a production order number, is received from the works manager, say for twelve completed machines of one sort and size. This production order is first divided into as many shop or working order numbers as is considered advisable, these numbers being noted on it. It is then passed on to the draughtsman taking the job in hand, who affixes his initials on it when the drawings are completed. When drawing casting details a 36-in. by 24-in. sheet is generally used, and each casting is allotted a certain space; these spaces are all of regular size, and whenever possible 9 in. require more than this size, and then a space twice or four times this is allowed, but all spaces are made so that if taken separately they will fold up to 9 in. by 6 in.

SUBJECT-MATTER PATTERN INDEX.

The objects aimed at in allotting each piece a certain regular space are: (1) to make each a complete drawing in itself with a name and a number, the number being the pattern number; (2) the compilation of a "subject-matter pattern index," which is effected by cutting up the blue prints when returned from the shops, and filing in a 9-in. by 6-in. card index, which index the author thinks it would be impossible to obtain economically in any other manner. In a few years' time, no matter what sort of piece is required, it will be possible to tell if there is a suitable pattern for it in existence, by referring to this subject-matter index; should only the number of a pattern be known, it is possible to find the number of the drawing on which it appears by referring to the numerical pattern index, which is also kept on the card system. For any material required to be ordered out, and in this particular business few machines are made in which this is not the case, a purchase requisition is written in triplicate, one copy going to the purchase department, two copies being retained in the drawing office,

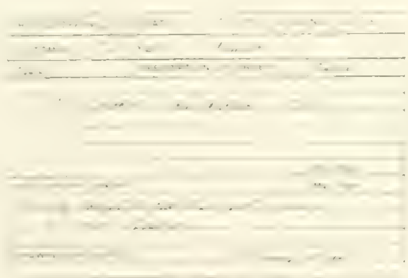


FIG. 3. SHOP ORDER FORM.

FIG. 6. DRAWING INDEX CARD.

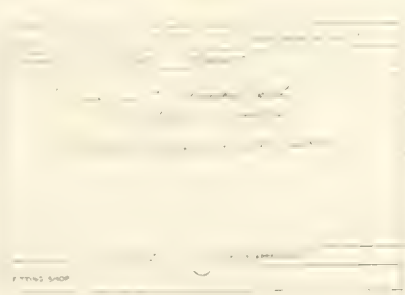


FIG. 4. SHOP ORDER FORM.

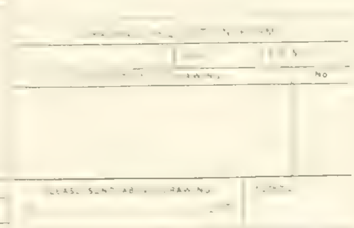


FIG. 7. DRAWING REQUISITION FORM.

[illegible] is torn out and [illegible] record of all material ordered out for any one number is automatically collected, thus obviating serious delays likely to occur through parts, which should have been ordered out, having been overlooked when an order is repeated.

SHOP ORDER SHEET AND PRODUCTION ORDER COVER.

As the drawings are completed, the various parts required for each shop order are type-written in quadruplicate on specially ruled foolscap sheets (fig. 1). The first of these copies remains in the drawing office, the second goes to the cost clerk, and the remaining two go into the shops. These detail shop orders form the foreman's authority for putting the work in hand in their respective departments. As there may be several shop order numbers for one production order, they are collected together in what is called the production order cover (fig. 2). The weight of each casting or forging, as it is made, is entered on the detail shop order sheet, and eventually, in the case of castings, on the pattern number card index, thus giving the drawing office useful information which hitherto had not been obtainable without reference to the cost-keeping book.

The detail production orders are found to be immensely useful in the various shops for checking over the quantities, etc., and more especially is this noticed in the machine shop, where they enable the foreman to keep all the parts on the move much more readily than if he had only the drawings to work from. A copy of each detail order sheet is also sent to the stores, thus enabling the storekeepers to look out all the material required for it ; this also gives them time to order anything they are short of. All these production orders are returned to the drawing office through the cost clerks' department, whose business it is to check the weights with the delivery notes they have already received from the stores. In this system a record of all material used for an order has to pass through the storekeeper's hands at one time or another.

REPAIR PARTS AND SUNDRY ORDERS.

With regard to repair parts and sundry orders which are always urgent, the order, just as received from a customer, is sent into the drawing office, and a shop order form (figs. 3 and 4) is issued to all departments concerned. This method gets the work put in hand very quickly, and as each department returns its order as soon as it has completed it, from any which are not returned it is immediately known where the job is stopped. A bright red label printed URGENT is fixed on breakdown and other very urgent repair orders.

TOOL OR CUTTER SHEET.

Concerning the tools and cutters, etc., previously mentioned as bearing a detail number, a very great difficulty was at first experienced in the new works, owing to more than one detail number appearing on one drawing ; and as one item might be used for a large number of customers, and to write the name of each customer on the drawing caused endless confusion, the following method has since been devised, which seems to meet all requirements : A form (fig. 5) was drawn out, and a quantity obtained on thin parchment paper, the printing on it being black. Each tool or cutter is now drawn on one of these forms to scale, and a record is kept in the table at the right-hand end of it, of the customer's name, shop order number or inwards order number, quantity required, and the trade-mark ; the record of the trade-mark is a very important item, because where a large quantity of tools is used, they cannot always be obtained from the same source, and in the case of complaints being received from a customer the name of manufacturer of goods can instantly be ascertained. As will be seen from fig. 5, each article made from a detail number drawing bears its number, so that all a customer has to do when requiring a further supply is to quote the number and date on the tool itself. The detail number drawings bearing the tabular record of customers' names are filed away under their subject headings, and being all one size they form a card index.

A blue-print of each is also kept ; these are filed away in numerical order, also in a card index. These two indexes thus enable any detail number drawing to be found immediately, no matter whether only the number or the name be known. With very little expense these records could be duplicated by blue-printing, and thus a stores reference index could be formed, which would also be a safeguard against fire. A 5-in. by 3-in. card index of customers' names is also kept in the office ; for all machines and repairs, etc., ordered by them a white card is used ; for tools, etc., ordered, a salmon-coloured card is used.

DRAWING INDEX (CUSTOMERS').

All drawings sent out are indexed under the name of customer they are sent out for ; for this a blue card (fig. 6) is used. There is also a machine index kept, all machines made being indexed under the class and size ; for this a white card is used. All drawings received in the office are numbered and filed away in pigeon-holes. All samples of work done on the machines manufactured are numbered, recorded, and kept in a sample room which is in charge of one of the junior draughtsmen. All catalogues received are kept in the drawing office, being filed away according to their size, the stiff-covered ones by themselves, and the limp-covered ones in cloth-covered pamphlet boxes. Two indexes are kept of these, one of makers' names, and one subject-matter index.

Sketches are made in numbered sketch books, each page also being numbered in duplicate ; the sketch is duplicated by carbon paper, and being already numbered no other reference is needed. Specifications of shafting, belting, piping, etc., are written in copying pencil on forms printed in copying ink, and press-copied in a book in the ordinary way. Complete specifications are compiled for each new machine made, by the draughtsman in charge of the job , in this manner any alterations in design are recorded, thus helping to avoid mistakes occurring when tenders are being sent in, and which, when they do occur, are apt to prove very costly.

DRAWING REQUISITION FORMS.

Each department in the works is supplied with a pad of drawing requisition forms (fig. 7) one of which forms is filled up and forwarded to the drawing office when a drawing is required. This obviates the necessity of a foreman having to hunt round for a piece of paper on which to write his requests, or perhaps sending a verbal message which is translated into something quite different before reaching the office.

Autumn Meeting of the Iron and Steel Institute.

THE OUTDOOR PROGRAMME.

W[illegible] Iron and Steel Institute [illegible] Barrow. What may be termed the "outdoor programme" of the meeting, comprising visits to works, excursions, and entertainments, was no less successful, and doubtless the attractive nature of the social functions had a great deal to do with the large attendance of ladies. These arrangements, in common with the more serious features of the meeting, passed without a hitch of any kind. On the evening of the ball the weather, which had at times threatened the outdoor proceedings, proved entirely adverse, but, luckily, an ample sufficiency of carriages enabled the guests to set the weather at defiance. The works of the Hematite Company were visited on September 1st, a thorough inspection being made with the assistance of a large staff, under the direction of Mr. J. M. While. The The total number of hands employed at these works is about 3,500, exclusive of those at the coal and iron mines, which are extensive, and about 250 at the wire-works. The area of the land occupied by the company's works, including railway sidings and reservoirs, is 245 acres.

A party consisting of about thirty members of the Institute, made a thorough inspection of the Askam Ironworks of the Millom and Askam Hematite Iron Company, Ltd., under the guidance of the directors and Mr. Axel Sahlin.

A notable visit was paid to the shipbuilding yard and engineering works of Messrs. Vickers, Sons and Maxim, Ltd., though the occasion was unfortunately marred by wet weather. At the quay wall the Chilian battleship *Libertad*, and the British battleship *Dominion* were being completed.

Special trains were provided by the Furness Railway Company for the convenience of members participating in the various excursions, and a visit was paid to the principal workshops of the Company, to which have recently been added a new iron and brass foundry, 100 ft. long by 45 ft. wide, and provided with a 10-ton overhead electric travelling crane, a cupola capable of melting four tons per hour, moulding machines, pneumatic plant, etc.

The new Hodbarrow sea wall and the various works which have been undertaken as sea defences for the protection of the Hodbarrow mines were inspected by a party of about 150, including ladies. The first sea-wall, which was completed in 1890, is constructed of concrete, backed by a clay embankment, and rendered water-tight by a wall of puddled clay, immediately behind the concrete wall, keyed into the natural clay bed beneath. This was built to enable the company to win the ore up to the then high-water mark of ordinary spring tides. The outer barrier differs from the existing sea wall in that it is a flexible instead of a rigid structure, this form having been adopted in order that should any subsidence take place beneath the barrier, it also will subside, and accommodate itself to the contour of the ground when by adding material to the superstructure its efficiency as a protection to the mines will be maintained. The total length of the outer barrier is 6,870 ft., or rather more than a mile and a quarter. It has an extreme height of 40 ft., the depth of water alongside at high tides being 20 ft. to 25 ft, and its greatest width is 72 ft. at the level of the roadway, and 210 ft. at the base. The cost of the undertaking is about £480,000.

At the close of the first day's proceedings, the Mayor and Mayoress of the Borough—Mr. and Mrs. Fisher—received a large number of visitors, including the President (Mr. Carnegie), and Mr. Victor Cavendish, M.P. at a conversazione held at the Town Hall. On the following evening, a highly successful ball was held, at which at least eight hundred guests must have been present.

On the Thursday a very delightful afternoon was spent in the grounds of Holker Hall, where Mr. Victor Cavendish, M.P., and Lady Evelyn Cavendish arranged a garden party, which was very largely attended.

Perhaps the most pleasant function connected with the social side of the meeting was the musical evening arranged at Furness Abbey, when the buildings and walks were outlined in coloured lamps. The musical part of the programme was carried out by the Ship Yard and Steel Works Bands, and the evening's attractions included the display of fireworks.

An enjoyable excursion was made to the Lakes, and at Grasmere several groups of the members and their lady friends were photographed. On the Friday an expedition was undertaken to Fleetwood and Blackpool. Between two and three hundred members participated, the trip over Morecambe Bay to Fleetwood, occupying a little over an hour, and being greatly, enjoyed. The party lunched at the Hotel Metropole, at the invitation of the Reception Committee, where Mr. G. J. Snelus paid a tribute to the excellent work of the Reception Committee, remarking that the guests were exceedingly indebted to the Committee for the trouble taken by them in according the members so hearty a welcome to Barrow, and also for the kind and abundant hospitality extended towards them. Mr. T. F. Butler, in response, said that the Committee had done their best to entertain the Institute, and were pleased that their efforts in this direction had been so highly appreciated.

Photo by Arthur H. [illegible], Barrow.] THE IRON AND STEEL INSTITUTE MEETING—GARDEN PARTY AT HOLKER HALL.

The group includes (from left to right):—Messrs. Herbert Pilkington (Chesterfield), James Morgan White (Member of Council), Alfred Aslett (General Manager, Furness Railway Company), George J. Snelus, F.R.S., Vice President) Andrew Carnegie, LL.D. President (*in centre*) and James F. L. Crossland (Manchester)

Photo [illegible] Arthur H[illegible], Barrow.]

THE IRON AND STEEL INSTITUTE MEETING—A GROUP TAKEN AT GRASMERE.

First Row (on ground): Messrs. E. F. Lange (*who has been engaged in taking a snapshot of the photographer*) and Alfred Aslett (General Manager, Furness Railway Company).
Second Row: (*Centre of group*) Mr. James M. White (Member of Council), Mr. G. H. Dunn (Dudley) (*[illegible]*).
Third Row (*reading from right to left*): Messrs. William Whitwell (Past President), William Edgar Allen (Sheffield), E. I. W. Richards (Glo[illegible]), [illegible] and [illegible]
(Cardiff, *the fifth gentleman from the left*), Mr. George Ainsworth (Member of Council) (*second gentleman from the left*), Mr. R. M. [illegible] [illegible]
Above the Hedge (*in the extreme background near the porch*) Mr. A. M. Butchart (Local Honorary Secretary) and [illegible] Mr. Frederick [illegible]

[illegible]

ANOTHER GROUP AT GRASMERE.

First Row (*sitting on ground, reading from left to right*): Messrs. Axel Sahlin (Millom) (*extreme left*), J. O. E. Trotz (*second from left*), L. Yngstrom (Sweden) and Hubert S. Thomas (Llanelly) *in white costume*.

Second Row (*sitting on form, reading from left to right*): Messrs. C. Fera (Rome), C. H. Morgan (Worcester, Mass.), Alfred Aslett (General Manager Furness Railway) (*in centre of group*), Bennett H. Brough (Secretary of the Iron and Steel Institute), Robert Stead (Wakefield) and (*on the extreme left*) Mr. W. Lloyd Wise (London).

Third Row (*standing, reading from left to right*): Messrs. A. Pye Smith (London), J. F. Melling (Leeds), W. F. Cheesewright (*Iron and Coal Trades Review*), H. Pilkington (Chesterfield) (*with bowler hat*) and (*behind him in silk hat*) Prof. Thomas Turner, M.Sc. (Birmingham). Mr. John Hardisty (Chesterfield) (*above Mr. Aslett, to the right*), and Mr. F. T. Rollin (Sheffield) (*holding bowler hat*).

Fourth Row (*standing on bench behind, reading from left to right*): Messrs. F. H. Rudolph (London), William Edgar Allen (*above Prof. Turner*), Henry Webb (Bury), Joseph Adamson (Hyde) and Harry Marsden (Sheffield), with Mr. B. J. Skelton (London) *at the end of row*.

Fifth Row (*at the back, reading from left to right*): *Third from end* Mr. A. Etchells (Manchester), *fourth gentleman*, Arthur Booth (Redleaf) *with* F. C. Moorwood (Sheffield), *while the sixth gentleman standing* is Dr. Weiskopf (Hanover). Mr. William Beighton (Leeds) is *standing near porch in silk hat*. *To the right* are Messrs. R. Wilkinson (Cockermouth), H. G. Graves (London), Jacob Kean (Manchester), W. Hawdon (Stockton) (*carrying coat*), Hugo Sack (*immediately behind him*), Mr. W. T. Beesley (Sheffield) (*on garden seat below Mr. Williamson*).

Photo by Arthur H. de Barrow.]

THE IRON AND STEEL INSTITUTE MEETING—A GROUP AT THE WORKS OF MESSRS. VICKERS, SONS AND MAXIM.

OUR MONTHLY BIOGRAPHIES.

Mr. EDWARD PRITCHARD MARTIN, J.P.

IN metallurgical circles the name of Edward Pritchard Martin carries with it a reminder of the early days of one of the most noteworthy achievements in steel making —the Thomas and Gilchrist dephosphorising process. This was worked out by the two inventors, Thomas and Gilchrist, at the Blaenavon Company's works, while Mr. Martin was the General Manager there, and for his contribution towards it he was awarded the Bessemer medal.

Mr. Martin comes, on his father's side, from an old stock of mining people in Cumberland, and on his mother's side from an old Breconshire family. He is the eldest son of the late Mr. George Martin, who was mining engineer for the Dowlais Iron Company for upwards of 58 years.

Born at Dowlais in 1844, he was privately educated in England, and subsequently studied at Paris. He was apprenticed to the Dowlais Iron Company in 1860, under the late Mr. Menelaus, and later under Mr. Edward Williams, accompanying the latter to London in February, 1864, to assist him in the management of the London Office of the Dowlais Iron Company. In 1869 he became deputy General Manager of the Dowlais Iron Works under the late Mr. Menelaus, and in 1870 General Manager of the Governor and Company of Copper Miners in England at Cwmavor.

[illegible]

MR. E. P. MARTIN, J.P.

In September, 1874, Mr. Martin was appointed General Manager of the Blaenavon Company's Works, where he erected the Bessemer Steel Works, and where, as first mentioned, he identified himself with the historic work of Messrs. Thomas and Gilchrist.

In 1882 he was appointed General Manager of the Dowlais Iron Company under the trusteeship of Mr. Clark, thus following in the footsteps of his late friend and chief, Mr. Menelaus. On the amalgamation of the Dowlais Iron Company with the Patent Nut and Bolt Company, Ltd., he became Vice-Chairman and Managing Director of Guest, Keen and Co., Ltd. He retired from this position in June, 1902, but he still retains a seat on the Board of Guest, Keen and Nettlefolds, Ltd.

Mr. Martin is also a Director of the Orconera Iron Ore Company Ltd., the Rhymney Railway, the South Wales Electrical Power and Distribution Company, and other companies.

He is a past President of the South Wales Institute of Engineers, and of the Iron and Steel Institute, Vice-President of the Institution of Mechanical Engineers, a member of the Institution of Civil Engineers, a past President of the Monmouthshire and South Wales Coal Owners' Association, and a member of its late Sliding Scale Committee—now the Board of Conciliation—for the Coal Trade of Monmouthshire and South Wales.

He is a J.P. for the counties of Monmouth and Glamorgan, and Sheriff of Monmouthshire this year.

Mr. ALFRED ASLETT.

(General Manager of the Furness Railway.)

MR. ALFRED ASLETT was born in the City of York, where for many years his father—the late Mr. Alfred Aslett—was Divisional Superintendent of the Great Northern Railway.

Educated at York and Shrewsbury, Mr. Aslett naturally followed in the footsteps of his father, serving the Great Northern Company for twenty years—chiefly at Nottingham and King's Cross. After gaining further experience on the Eastern and Midland Railway, in the capacity of Traffic Manager of that line, he was appointed Secretary and General Manager to the Cambrian Railways in 1891. During his four years' connection with this line, he was instrumental in largely developing its passenger traffic, and in 1895, on his accepting the post of General Manager to the Furness Railway, the people of Aberystwyth showed their appreciation in a practical manner at a farewell dinner by making him a special presentation.

Under the management of Mr. Aslett, the Furness Railway has made rapid strides. The line, which was originally designed to develop the mineral traffic of the district, and which may be said to have been responsible for the making of modern Barrow, runs for a distance of 74 miles from Carnforth to Whitehaven. At Carnforth there are connections with the London and North-Western and Midland Railways, and at Whitehaven with the former line. Branch lines also run to the lakes and from Barrow to Piel.

The railway owed its inception to the late Sir James Ramsden, whose scheme also provided for the Barrow Docks. Extending over 294 acres, these magnificent waterways are deep enough to accommodate the largest steamers afloat. They cost the company some 2½ millions sterling, and the important part played by them in connection with the works of Messrs. Vickers, Sons, and Maxim is well known. The Docks form quite a distinct department, which is directed by a harbour master, and gives constant employment. to some half a dozen steam tugs.

What the company has lost in mineral traffic it may be said to have gained by the thorough exploitation of the numerous pleasure resorts in the neighbourhood. On its arrangement for traffic between Barrow and Belfast and with the Isle of Man, in connection with the Midland Railway Company and Messrs. James Little and Co., the company has spent something like half a million of money. It runs five steam yachts on Windermere Lake, a gondola on Coniston Lake, and two steamers for excursion traffic between Fleetwood (for Blackpool), Morecambe, and the lakes, *via* Barrow. The line possesses a remarkably fine stretch of coast scenery, and its natural advantages have been made the most of; in fact, by increasing the passenger traffic, introducing new and more efficient locomotives and rolling stock, lighting the carriages with electricity, running its trains on more liberal scales, adorning its stations with shrubberies, etc., the railway has been rendered one of the most attractive in England.

In assigning credit for these developments, allowances must of course be made for these efforts of an enterprising board of directors and an able staff of officers, but a large share of the credit for initiatory work and successful organisation unquestionably belongs to Mr. Aslett.

MR. ALFRED ASLETT.

"THE ENGINEER IN SOUTH AFRICA."

THIS is the title of an essentially interesting and informative work by Stafford Ransome, M.Inst.C.E., which makes a notable addition to the literature of the subject. Mr. Ransome was originally commissioned by the *Engineer* to write a series of articles on South Africa from an engineer's point of view, and these have been drawn upon to a certain extent in compiling the twenty chapters of the present volume, but at least a third of the original matter has been deleted, while the remainder has been re-arranged and in some degree re-written.

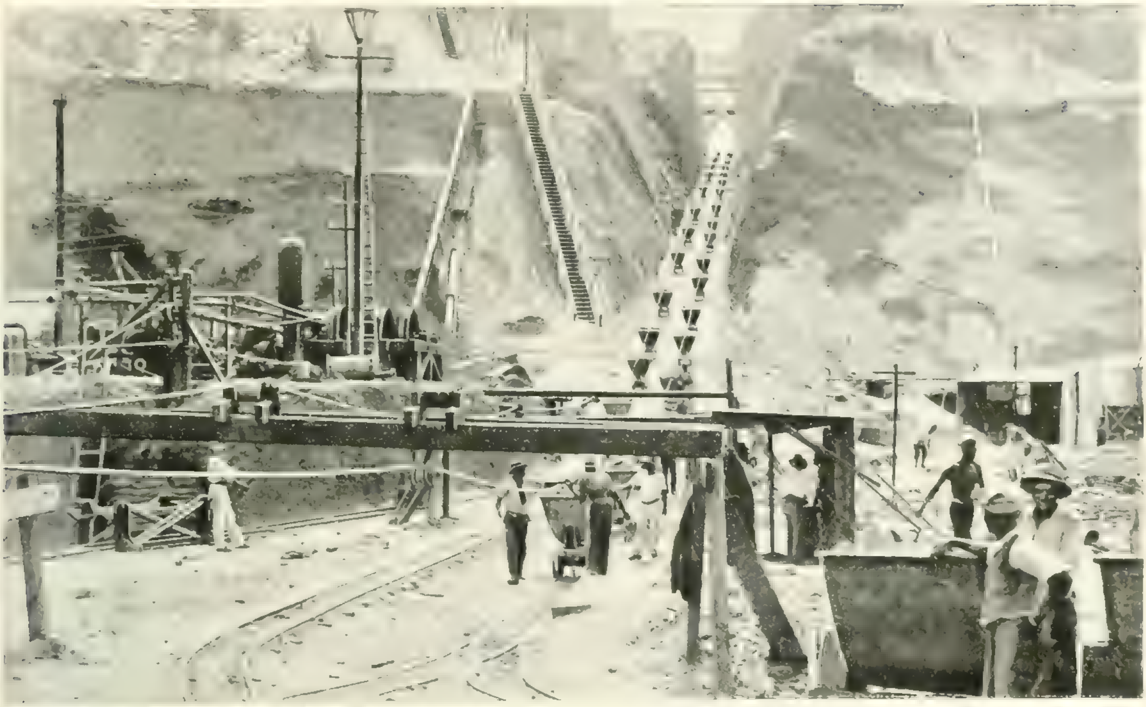
In order to enlarge the scope of the work, the author has been careful to avoid a severely technical style. In summing up his line of argument, Mr. Ransome remarks that the passing of the sponge over the slate in South Africa, from a military and political point of view, has had the effect of altering and, to some extent, effacing the commercial and industrial map of the country as we have known it. Some of the most familiar landmarks have been partially obliterated and others have sprung into being. The industrialist must draw a new map of South Africa, a map in which the present political boundaries will be of decreasing importance. The South Africa of the future will be ruled not by the seaports, or even necessarily by the coastal colonies, as in the past, but by the great industrial centres.

"The Engineer in South Africa: a review of the industrial situation in South Africa after the war, and a forecast of the possibilities of the country." By Stafford Ransome, M.Inst.C.E. Archibald Constable and Co., Ltd. 7s. 6d.

In a chapter entitled "The British Manufacturer," Mr. Ransome makes some attempt to sum up the future of British trade in South Africa. He remarks that time alone will show how our position will be affected, but at all events we may rest assured that in Cape Colony we enter upon the struggle with the advantage of a very long start. He thinks there is more joy in America or Germany over one order that goes to those countries, and might have come to us, than there is in England over ninety and nine such orders which come to us in the ordinary course of business. The tendency to jubilation in the American Press over orders for machinery, and the exaggeration of the importance of such orders, are in a great measure responsible for the alarmist views with regard to the position of the British manufacturer. Our position with regard to all machinery and appliances in the electrical trade is nevertheless extremely critical. On the railways practically all the machinery, and about half the rails, come from England —American locomotives have been tried and found wanting. The British manufacturer is equally to the fore in harbour works requirements and other specified directions. Various complaints of the British manufacturer are discussed, and should be carefully studied. The question of packing and making the author believes to be a genuine grievance against the average British manufacturer. With regard to representatives, he urges the importance of sending out the very best technical men they can find, paying them well and being guided by their advice. Among the machines that are

From "The Engineer in South Africa."

WASHING THE STREETS OF KIMBERLEY FOR DIAMONDS.



[From "The Engineer in South Africa."]

MECHANICAL HAULAGE AT THE PREMIER MINE, KIMBERLEY.

mostly wanted in Cape Colony at the present day are agricultural plant, windmills, traction engines, railway plant, dredges, cranes, pumps, drills, steam and oil engines, flour-mill machinery, brick-making machinery, machine tools, and electrical lighting and driving plant —more particularly small motors. There is practically no market for gas-engines, for the simple reason that where there is gas the price is prohibitive for motive-power purposes, on account of the cost of coal.

He states that the industrial prospects of South Africa are brilliant, but the country must have time to recover from the effects of the long devastating war. In spite of the repeated attacks on the methods of the British manufacturer, and the categorical statements that have been made to the effect that he is indifferent and blind to his own interests, and that he is, in consequence, losing his trade with South Africa, the author has been unable to find any foundation for these allegations. The chapter on "The British Manufacturer" was written last September, at a time when there were no normal statistics available since the war. The somewhat optimistic views then taken by the author, however, have been more than confirmed by the statistics recently published of the imports into Cape Colony, the "rebel colony," for 1902. The author estimated that Great Britain's share in the engineering imports was not less than 66 per cent. of the total. The new statistics shew that of the imports of all classes from all sources in 1902, Great Britain furnished 66 per cent., and that a further 10 per cent. was furnished by British possessions, making a total of 76 per cent. for the Empire. This leaves a balance of 24 per cent. to be divided amongst the various countries who, it is alleged, are ruining that proverbially short-sighted firm John Bull and Sons. Incidentally it may be mentioned that the invoice for 1902, for goods delivered by this "obsolete" firm, amounted to just double the figure of their invoice for 1898, which was the last normal year before the war.

There is an important chapter on the labour question, in which the author gives a detailed explanation of the Compound system, urging that it is the only proper and certainly the most humane way of dealing with the Kaffirs His only reason for advocating this system for gold and other mines, where there is nothing for the native to steal, is on the score of humanity.

Mr. Ransome tells in a fascinating way the story of Kimberley. He cites a striking proof of the early primitive methods of mining for diamonds.

"In olden times a good deal of this debris from the mines was used for making up the streets of Kimberley. At the present day, only a few hundred yards from the room in which I am writing, individuals are engaged in "washing" the streets for diamonds. This process is shown by the picture. . . . . In spite of the fact that the municipality stipulate that the streets shall be left in a better state by the washers than when operations began, these enterprising men are demonstrating the fact that Kimberley is literally paved with diamonds, and are making a very good income out of the stones they find."

There are many other attractive features in this valuable volume which we recommend to the attention of all who are interested in the development of South Africa.

TWO GREAT NAVAL INSTITUTIONS.

A brief account of a visit to the new Naval Barracks at Portsmouth, and the Royal Naval College at Osborne.

By ARMISTEAD CAY.

A LARGE party of gentlemen interested in naval affairs travelled down to Portsmouth on Saturday, September 12th, by special invitation in order to view the new Naval Barracks erected there, and also the Royal Naval College lately opened by His Majesty the King, at Osborne.

On the arrival of the special at Portsmouth Naval Barracks Station, the visitors descended from the train to the line by means of portable stairways placed in position by bluejackets, and, having been courteously received by the Commander-in-Chief (Admiral Sir J[illegible] led at once to the Naval Barracks where there was an exhibition of drill on the Swedish system the men performing some astonishing evolutions, which afforded a capital idea of the way in which the muscle of the Navy is made. A suggestion of ample space and extreme order seemed to obtain everywhere in these well-lighted buildings, and the same impression was maintained out in the huge parade ground where the boys were drawn up for musical drill.

The barracks are destined to play an important part in the new naval arrangements as a centre of training, and the temporary home of "nucleus crews"—the highly-trained men who will form the backbone as it were, of the complements of our warships. Occupying an area of about 50 acres, they offer accommodation for over 6,000 officers and men of a vastly superior description to that available in the old hulks which were formerly used. The men's quarters are lighted by electricity, and fitted with excellent bathrooms and modern sanitary appliances. Unfortunately, there was not sufficient time to inspect the whole of the barracks, but enough was seen to impress the visitors with the fact that nothing has been left undone to secure the conditions that shall spell efficiency.

The officers' quarters are, of course, more ornate, and present an imposing façade. The main entrance hall, 24 ft. long, and 21 ft. wide, was particularly admired. Oak, with hammered iron for the fittings, is chiefly employed, the panels of the marble staircase being enriched with the admirably carved representations of ships. Many fine rooms are included in the central block, the most notable being the messroom—a spacious apartment in oak, with an open timber roof. Here an excellent lunch was served, while from the musicians' gallery floated the strains of "H.M.S. Pinafore" and other music appropriate to the occasion. The accompanying snapshot was taken as the visitors [illegible].

Admiral Fisher presided over his guests with a good-humoured geniality, but called for no speeches, contenting himself merely with an expression of contentment at the state of the weather. This may or may not have been tempting Providence; the fact remains that an expedition by train round the dockyard was commenced almost immediately afterwards in heavy rain. This, however, did not prevent the visitors from noting many points of interest in the wonderfully diverse collection of fighting ships now in the docks, ranging from the *Inflexible* (the most up-to-date warship afloat twenty years ago, but now old iron) to the huge armoured cruiser *King Alfred*, an excellent example of the conditions obtaining to-day. A flotilla of destroyers offered further food for reflection, and among other notable craft we observed the turbine vessel *Velox*, described and illustrated in a previous number of PAGE'S MAGAZINE.

The party subsequently embarked on the tug *Volcano* at the North Jetty of the dockyard, and, as time did not permit of a visit to Whale Island, the boat was soon under steam for Cowes. The passage was not by any means destitute of excitement, for the vessel was given over to a feigned attack by submarines, and these queer craft, running at full speed on the surface, or eluding observation and our camera while partially submerged or diving, afforded a wonderful object-lesson of their insidious power in modern warfare.

We soon came to the conclusion that photographing the submarine on a dull day may be compared to chasing the *ignus fa'uus*. There is an effective way of dealing even with submarines. Near the buoy marking the old wreck of the *Boyne* was an outrigger torpedo-boat and a huge volume of water thrown into the air, marked the explosion of a heavy charge, causing a convulsion in the sea which would have made a speedy end of any unfortunate submarine within striking distance. A distinguished naval officer jocularly described this as "putting salt on her tail"—an apt simile.

The *Volcano* was accompanied by several destroyers, which gave remarkable evidence of the mobility of these craft, and the deadly effect they would have in modern naval warfare.

At Spithead we passed a gunboat (shown at the head of this page as it appeared from the *Volcano*) carrying a 4·7 gun firing at targets 6 ft. square, and directed by Chief Petty Officer Bate, who had charge of it from Durban to Ladysmith, and broke down Colenso bridge at a range of considerably over four miles. The firing was most successful, and ended with the demolition of the targets.

On landing at Trinity Pier, East Cowes, the party proceeded first to Kingston, an adjunct of Osborne, to inspect the engineering and mechanical workshops, which have been built for the use of the cadets close

Two Great Naval Institutions.

[illegible] everything necessary to familiarise the [illegible] cipal building, and the water there are cadets' dressing-rooms and [illegible] while to the south are [illegible] the laboratory. In the power-house there are a small brass foundry and a smith's [illegible]

The steamboats attached to the College [illegible] signed 60-ft. launch, intended mainly for instructional work, and built by Messrs. J. S. White and Co., at Cowes. The whole of her machinery space is enclosed in a large glazed cabin, extending nearly the whole length of the boat, and intended to serve as a lecture-room. Here the cadets will be taught to take to pieces and put together again engines which have been broken down or need repair, and will study other practical illustrations of marine engineering.

[illegible]

Much interest was evinced in these admirable arrangements, but the time was limited, and, aided by the good offices of Captain Wemyss, the Governor of the College, who threw himself with characteristic energy into the work of superintending the transportation of the guests, the party drove over to the College by the newly made road.

Single-storied buildings on the bungalow plan have been employed throughout, the material chiefly used being uralite. This system offers an economic and rapid method of construction and as one of these bungalows can be built in three months, there will be little difficulty in adding additional accommodation as it is required. The picturesque aspect of the college from a distance is added to by the high water tower which rises from the centre.

Bungalows affording sufficient accommodation for seventy-five cadets are already in existence, and the foundations have been laid for half-a-dozen others. The buildings include a spacious messroom, numerous classrooms, a large gymnasium, apartments for the staff, and others for the commissariat department.

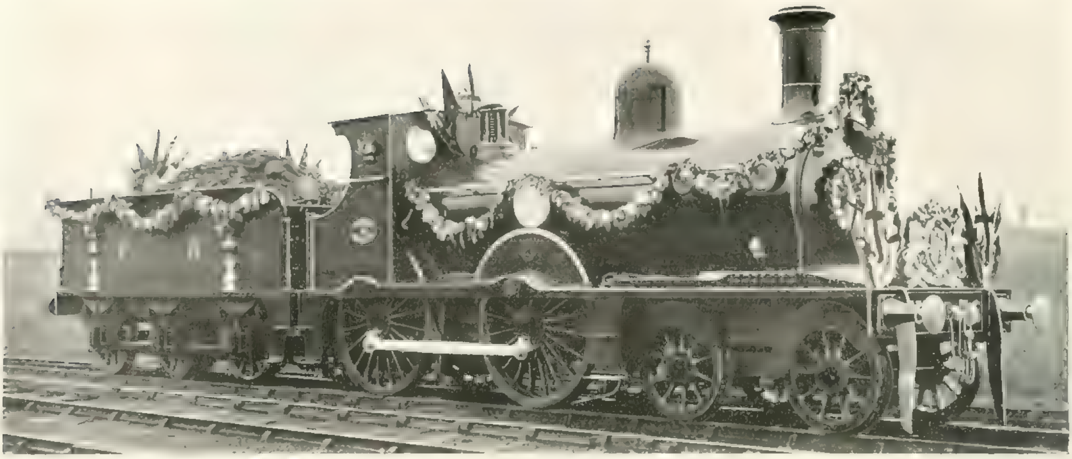
The bungalows which form the cadets' dormitories are 105 ft. long by 24 ft. wide, each holding thirty beds and including an officer's cabin. At the [illegible] room including a plunge bath, 10 ft. by 12 ft. The buildings are connected with one another and with the gymnasium by a long covered verandah.

The officers' quarters, shown in our photograph, are a separate block of buildings. Here, before re-embarking on board the *Volcano*, the members of the party were hospitably invited to tea by Captain Wemyss.

The opening of the College, which is now in full working order, unquestionably marks the beginning of an important era in naval affairs.

THE NEW NAVAL BARRACKS AT PORTSMOUTH.

A Snapshot of the party leaving the Officers' Quarters.



THE ENGINE USED BY THE FURNESS RAILWAY COMPANY ON THE OCCASION OF THE VISIT OF H.R.H. PRINCESS LOUISE.

NOTES AND NEWS.

A Notable Engine on the Furness Railway.

This engine was used by the Furness Railway Company during the visit of Her Royal Highness Princess Louise to Barrow-in-Furness, on August 25th, in connection with the launch of H.M. Battleship *Dominion*, by Messrs. Vickers, Sons, and Maxim, and the opening of the New Technical Schools. The engine is of the four wheels coupled type, with leading bogie, and was built by Messrs. Sharp, Stewart, and Co. (now amalgamated with the North British Locomotive Company), Glasgow, in 1896. The cylinders are 18 in. in diameter, by 24-in. stroke, the coupled wheels, 6 ft. diameter; and bogie wheels, 3 ft. 6 in. diameter. The total heating surface is 1,208 square feet, the grate area 17 square feet, and weight of engine and tender in working order, 69½ tons.

Rapid Coal-Handling Machinery.

The coal handling machinery installed by the C. W. Hunt Company, West New Brighton, N.Y., at the Lincoln Wharf Power Station of the Boston Elevated Railroad Company, recently lowered the world's record for rapid unloading. The coal was raised 90 ft. above tide-water, and delivered to the storage pockets at the rate of 320 tons per hour. The installation follows in general design the standard Hunt steeple tower rig, the moving gear and coal cracker being electrically driven, and the hoisting engine direct connected. The overhang of the folding boom is 40 ft., and the capacity of the shovel two tons.

The Junior Institution of Engineers at Sheffield.

The summer meeting of this Institution was exceptionally well attended—a circumstance no doubt due to the particularly attractive character of the programme provided. The proceedings opened at the Town Hall, Sheffield, where the members were welcomed by the Lord Mayor, after which a visit was paid to the works of Messrs. Davy Brothers, at Attercliffe, where they had the opportunity of seeing in course of erection a powerful armour-plate mill intended for the Imperial Japanese Government.

The next visit was to Messrs. Hadfield's Steel Foundry Company's Works, at Tinsley. On arrival, the members were entertained to luncheon, Colonel Sir Howard Vincent, M.P., presiding. A most interesting afternoon was spent in the inspection of the foundry, where steel castings for hydraulic, marine, and other machinery, track work, points and crossings and mining machinery of all kinds were being turned out. Subsequent visits were paid to the works of Messrs. Charles Cammell and Co. (where, on their arrival, an armour-plate for H.M.S. *Hindustan* was specially rolled). Messrs. James Dixon and Sons, John Henry Andrew and Co., Thomas Turner and Co., and Mellowes and Co. Ltd., were also visited.

Some capital speeches were heard at the annual dinner, when an illuminated vote of thanks was presented to Mr. Ernest King, in recognition of his valuable service as honorary local secretary of the meeting.

An excellent programme of excursions in the Peak district included visits to Haddon Hall, Chatsworth, and Castleton.

MOTOR-CAR OF EXPERIMENTAL TRAIN ON THE SPRAGUE-THOMSON-HOUSTON SYSTEM.

The Electrification of the Metropolitan District Railway.

Since we last went to press it has been decided that the electric trains for the Metropolitan District Railway shall be worked on the Sprague Thomson-Houston system of multiple unit train control. Motor-cars on this system have already been substituted for separate locomotives on the Central London Railway, in order to overcome vibration troubles, and are also being introduced on the Great Northern and City Railway. Each train will be composed of three motor-cars and three or four trailers, all being under the control of one driver, and the motor-car portion will be separated from the passenger part of the car by means of a fireproof steel partition. For the accompanying photograph we are indebted to the British Thomson-Houston Company.

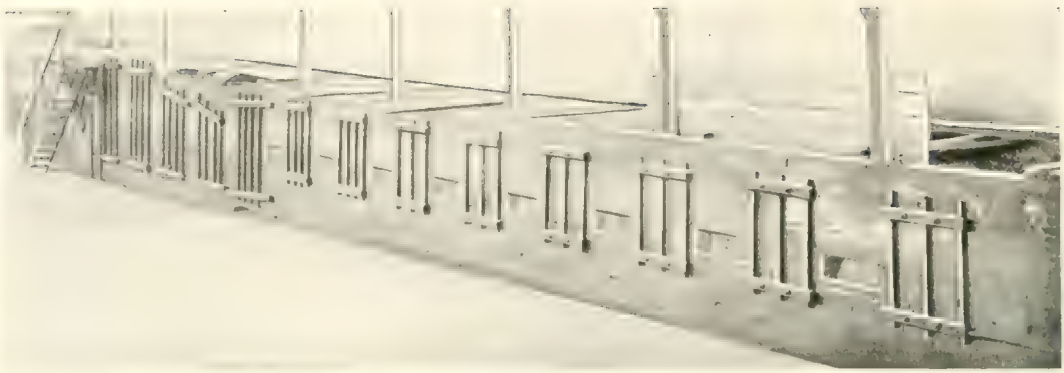
Business and Professional.

The Yost Typewriting Company have just introduced a new and improved form of their machine. The No. 10 Yost has a slightly enlarged keyboard, seven additional keys, enabling it to be freely used for special purposes—such as the writing of French or German, or mathematical work, without in any way detracting from its utility for ordinary commercial purposes. The shape of the keyboard has also been modified, and the key tops or buttons have been fashioned in such a way as to adapt them to receive the finger tips without danger of slipping. Other improvements include an alteration in the system of compound leverage, which saves noise, and greatly lightens the "touch" of the machine.

Contracts recently secured by Messrs. Mather and Platt, Ltd., of Manchester, include a complete electrical power and lighting plant for shipment to South America, comprising three combined sets of engine and dynamo, each of a capacity of 200 kilowatts, and two sets of 60 kilowatts each, with two surface condensing plants, provided with motor-driven circulating and air pumps, and each capable of dealing with 12,000 lb. of steam per hour. The generating plant will furnish power to 45 continuous current motors, varying from $1\frac{1}{2}$ b.h.p. to 42 b.h.p., five of these being direct coupled to centrifugal pumps, and two to the condenser pumps. Another important contract comprises a complete three-phase power plant for a cotton mill. The direct-coupled three-phase generator runs at 330 revolutions per minute, and gives an output of 550 kilowatts, with a frequency of 50 cycles per second at 440 volts. There are twenty-three induction motors, the majority of which are of 25 b.h.p.

Messrs. Royce, Ltd., Electrical and Mechanical Engineers, of Manchester, have completed and started up the new works which they have erected at Trafford Park for the manufacture in quantities of dynamos and motors. The works, which cover a large area, and include a fully equipped iron foundry, are electrically driven throughout, have been expressly designed with a view to promoting rapid and economical production, and are equipped with a wide selection of the latest automatic and other machine tools and labour-saving devices.

Mr. John A. F. Aspinall, M.I.Mech.E., M.Inst.C.E.—In our September issue Mr. Aspinall was inadvertently described as an Associate Member of the Institute of Civil Engineers. Our attention has been drawn to the fact that he is a full member of the Institution.



ONE OF THE CHLORINATION ROASTING FURNACES AT THE ROBINSON MINE.

THE EQUIPMENT OF THE ROBINSON MINE, JOHANNESBURG.

BY

EDGAR SMART, A.M.INST.C.E.

The present instalment concludes the author's survey of the mine. The previous articles dealing with incline shafts, power plant, mill, water regulation, cyanide plant, etc., appeared in the August and September issues. The chlorination works, a description of which is now continued, form a special feature of interest, as this is the only mine on which the process is practised at the present time.—ED.

III.

ROASTING OPERATIONS.

THE concentrates are dumped from trucks on to the flat top of the furnaces as required, and are fed in through doors in the roof at the back end in lots of two tons each. The furnace contains 6 tons on the whole 60 ft. of hearth, so that there are three charges in different stages being roasted simultaneously, and as far as possible these charges are kept separate throughout the roasting.

Thus, when one charge is finished and discharged, the whole of the ore on the next 20 ft. of hearth is worked forward on to the finishing hearth, and replaced by bringing forward all the ore from the last 20 ft., which is thus left empty. A fresh charge is then fed in and spread evenly over the back hearth. The roasting is therefore carried on by distinct steps at three stages of temperature, and in this respect the hand-worked reverberatory compares favourably with the mechanical type of furnace wherein the ore passes continuously from the lowest to the highest temperature, because in the former the roasting is more under control. In the hand-worked furnace the three hearths correspond with the three essential stages of the roasting operations, viz. :—

(1) The burning off of the sulphur at a low temperature with continual rabbling.

(2) Oxidation at a dull red heat with frequent rabbling.

(3) Completion of oxidation at bright red heat and decomposition of the sulphates formed during the previous stages.

With these furnaces it is therefore possible, by keeping the charges separate, to be quite sure that each stage of the roasting is properly completed before the next one is commenced, and, consequently, the roasting can be perfectly performed, so that where cheap labour can be obtained an automatic furnace is not required. And for this purpose kafir labour under competent supervision is quite as effective as that of white men.

When each charge is quite finished, about 20 lb. of salt is added, and is well stirred in immediately before discharging. The discharged

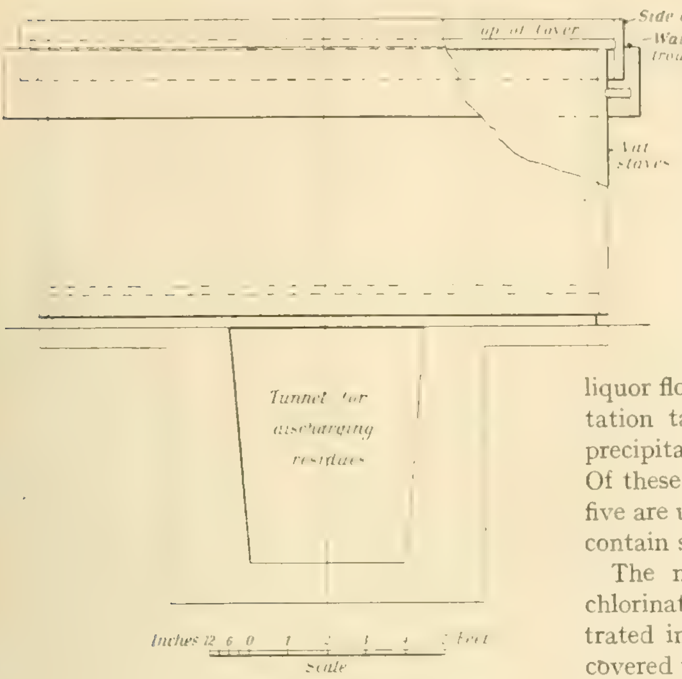


FIG. 12.

material is tipped and spread over a cooling floor and sprayed with water until it is just moist but not actually wet.

QUANTITY ROASTED.

With one rabble boy on each side, each furnace will turn out an average of 4·67 tons in twenty-four hours. At this rate of working the fire is fully made up just before the completion of each charge to give the great heat required to perfectly break up the sulphates; it then smoulders until the next charge is nearly finished. But when working at full pressure four rabbling boys are required on each side, and the fire is more frequently fed. The quantity roasted is then 8 tons in twenty-four hours. In each case one fire boy is employed for each furnace and one white man on each shift looks after the fire.

THE TANK HOUSE.

This building contains eleven chlorination tanks, 14 ft. in diameter and 5 ft. deep, with counterbalanced covers having a water seal when down, as shown in fig. 12. There are two plugged nipples in these covers, one for allowing excess chlorine gas to pass off as described below, the other for filling the tank with water. These treatment tanks are built in one line over a masonry tunnel, and the residues are discharged through the bottom of the tanks into trucks in the tunnel. There are eight precipitation tanks, each 12 ft. diameter, and two at 18 ft., all of them 6 ft. deep. There are nine safety tanks, each 16 ft. by 5 ft., through which the waste liquor flows in series after leaving the precipitation tanks, in order to save any very fine precipitated gold which may be carried over. Of these latter, two are filled with scrap iron, five are used simply as settlers, and the last two contain sand and gravel filters.

The method of forming the filters of the chlorination tanks as now practised is illustrated in fig. 13. The floor of the vat is first covered with rows of bricks laid on the flat, end on, with 1-in. spaces between the bricks in each row, and 3-in. spaces between the rows. These spaces constitute drainage channels for the solution as it percolates through the filter. These bricks are covered with an upper layer of bricks on the flat, laid close together in a direction at right angles to those beneath them. The next layer consists of cobble stones about 3 in. diameter; upon these there is put 3 in. of broken stone, and the filter is completed by a top layer of sand, 3 in. thick. Fig. 13 also shows the construction of a bottom discharge door suitable for chlorination tanks, designed by Mr. Charles Butters, and used in this plant.

A hole is formed in the wooden floor of the tank, and above this is fixed a flanged lead tube, the height of the tube being equal to the depth of the filter. The hole is closed by a cast iron door, supported and pressed up by a screw in a cross bar, which latter rests on two cast brackets bolted to the joists which carry the tank. When the lead tube is filled with sand and sealed with a slab of puddled clay, the door is perfectly watertight, and none of the iron work comes in contact with the chlorine.

GENERATORS AND CHLORINE PIPES.

There are three of C. Butters' patent chlorine generators, one of which is illustrated in the

photograph, (page 213). This type of generator has a lead-lined, cast iron, covered pan, about 5 ft. in diameter, with a jacket chamber beneath it, to which steam is admitted when required for heating purposes. The general construction of the apparatus can be well seen in the photograph. The jacket chamber is cast in the shape of a basin with three supporting legs and a top flange seen just above the white cross. The flange bolted on top of this carries the lower half of the pan, which is also dish-shaped, and dips down into the jacket chamber, thus leaving only a narrow space between for the steam. The cover is bolted to the pan by means of the upper circular flanges, between which the edges of the thick lead lining of the pan can be seen. A horizontal lead-covered paddle inside the pan is rotated by means of a vertical shaft driven through bevel gearing from the five armed pulley, by hand or power at about twelve revolutions per minute. The small horizontal hand wheel shown on top of the vertical shaft is for the purpose of adjusting the height of the paddle. Formerly the generators were lined with sheet lead 1 in. thick, but the present practice is to put in several thicknesses of $\frac{1}{8}$-in. lead, one of which can be taken out and replaced when worn by the grinding action caused by the stirring up of the manganese and salt by the paddle.

At this plant the following device has been added to each generator so that the amount of gas which is being produced may be observed. A lead lantern with glass windows is fixed on top of the generating pan and is partly filled with water. The gas outlet pipe from the generator passes up through this, and the end of it is bent down a little below the water so that all the chlorine gas has to bubble up through the water before it escapes by the delivery pipe at the top of the lantern. The ebullition thus produced is a rough guide to the amount of action going on in the generator, and enables the sulphuric acid to be added when necessary by observations instead of by guesswork.

The delivery pipes from the three generators are connected to a $1\frac{1}{2}$-in. gas main, which passes along the tank house near the bottom of the tanks. It has a branch leading towards each gassing tank, to the bottom of which, below the filter, this branch may be connected by a hose when required.

There is also a main excess gas pipe with branches, which may be connected either to the top or bottom of each tank by a short or long hose respectively; the use of this excess pipe will be explained below. All these gas pipes are, of course, made of lead.

EXTRACTION OF GOLD.

Before the moistened roasted ore is put into the tanks it is sieved through a $\frac{1}{8}$-in. mesh screen to separate out any clots of material which sometimes form in the furnaces, and which are of necessity imperfectly oxidised. These clotted portions are ground up and put into the furnace a second time.

In order to make the gassing operations quite

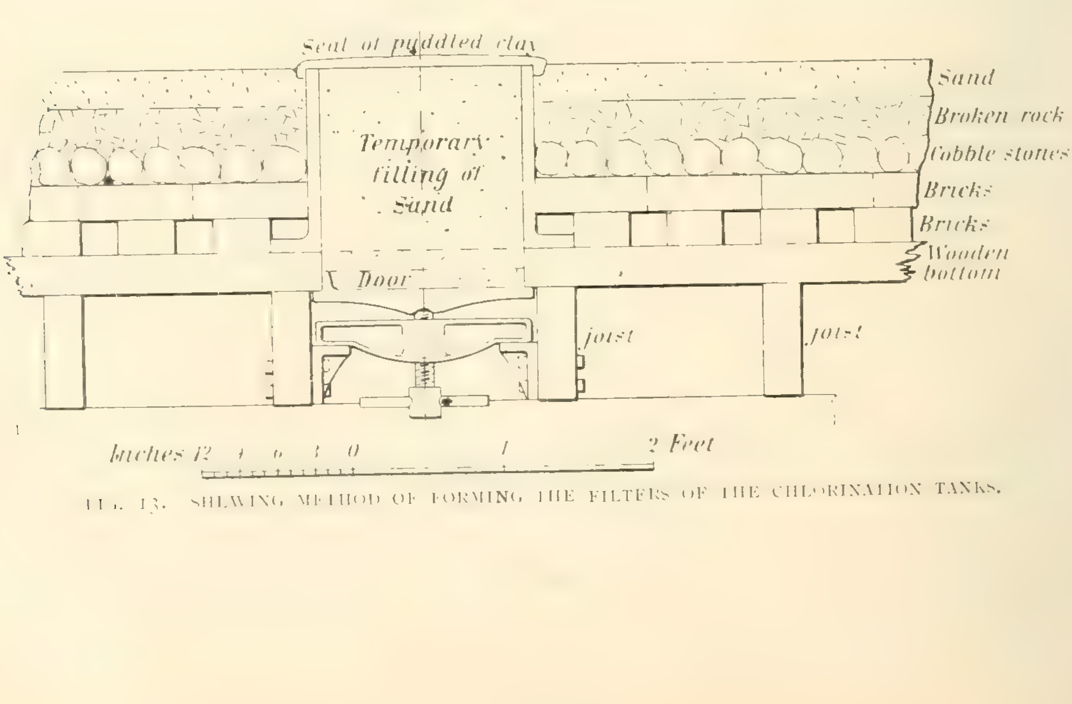


FIG. 13. SHEWING METHOD OF FORMING THE FILTERS OF THE CHLORINATION TANKS.

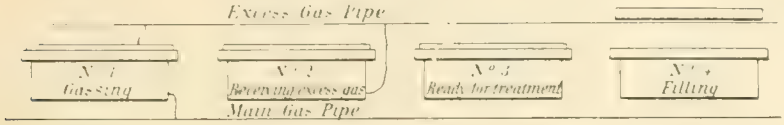


FIG. 14.

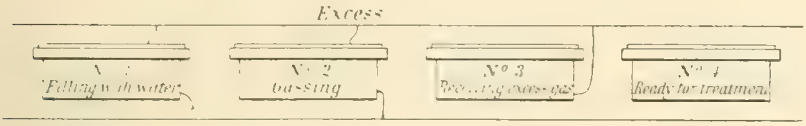


FIG. 15.

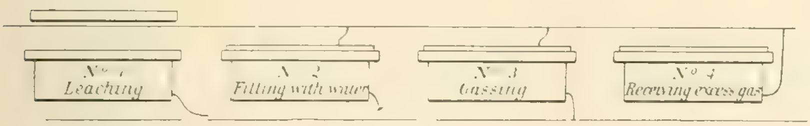


FIG. 16.

clear, diagrams 14, 15, and 16 are given, and it is assumed that tanks 1, 2, and 3 are charged with ore, and that the lids are down and sealed with water, so that the tanks are all gas-tight except for any open nipples in the lids. No. 1 is connected with the main gas pipe by a hose attached to a nipple at the side close to the bottom. The chlorine gas from the generator thus passes directly to No. 1 tank, whose top nipples are left open for the escape of air. When the tank is full, chlorine escapes in small quantities from the top nipples, one of which is then plugged, while the other is connected by a short hose to the excess gas pipe. The excess pipe is also connected by a long hose to the bottom nipple of No. 2 tank, so that all the gas now coming from the generator passes successively through tanks Nos. 1 and 2, this stage of the operation being shown in fig. 14. When No. 2 is full of gas, it is disconnected at the bottom from No. 1, and connected directly to the main gas pipe, while its top nipple is connected to the excess main, which is at the same time connected with the bottom of tank No. 3. At this time No. 1 is ready for filling with water, therefore the main gas connection is broken, and the same nipple is connected to a leaching hose which is stopped with an ordinary wooden plug at its free end. One top nipple is still connected with the gas main, while the water enters the tank at the other, and the arrangement of connections is now as shown in fig. 15. At this time No. 3 tank is not only receiving the excess gas from No. 2, but also that driven out by the water from No. 1. When the tank is full of water it is disconnected from the excess pipe, its lid is raised, and leaching is carried on in the ordinary manner. Meanwhile, tank 4 has been filled and is now connected at the bottom to the excess pipe, while No. 3 is receiving gas from the main and delivering to excess pipe, and No. 2 is filling with water and delivering to excess pipe also, as shown in fig. 16. In this figure the connections of 2, 3, and 4 exactly correspond with those of 1, 2, and 3 in fig. 15, and consequently the series of operations can be carried on in the same order indefinitely, each tank in succession receiving excess gas for about twelve hours and gas from the main for about twelve hours. The leaching occupies about twenty-four hours from the time the water is first turned on, the liquors being rich for the first eight hours. This time includes the percolation and draining off of the wash water used to displace all the chloride of gold solution.

When the gold-bearing liquor has all been run out of the leaching tank into the precipitation tank, the gold is thrown down in the latter by the addition of a strong solution of sulphate of iron, made on the premises from scrap iron, and dilute sulphuric acid. The liquor is tested from time to time (after being well stirred) by taking a sample of it in a beaker and adding thereto an excess of iron sulphate. When this addition produces no further precipitation in the beaker, the bulk liquor is again well stirred by a jet of air from a pump, and then allowed to stand for forty-eight hours, to allow the precipitated gold to settle on the bottom of the vat. The exhausted liquor, which then contains chiefly chloride of iron in solution, as well as sulphuric acid and sundry sulphates, is then decanted off through a series of plug holes in the side of the tank, placed at various depths from the top. These holes

are opened in succession as the surface level of the liquor is lowered; the decanted liquor passes through the series of safety tanks above described, and then is run to waste.

The precipitated gold is scraped up from the bottom of the tank and placed in small vats, in which it is conveyed to the smelting room.

RETORTING AND SMELTING.

The gold recovered in all branches of the treatment works is sent to the smelting department, where it is brought into marketable form. This work is under the charge of Mr. T. R. Thorpe, one of the best known metallurgical chemists on the Rand, who has been associated with the mining work on these fields since its very beginning, and who has turned out more than 1,700,000 ounces of gold bullion in smelted bars from this mine alone.

The plant in this department includes one retort with brick furnace complete in itself in a separate room. Also six calcining ovens in one row within the smelting room, all heated by one fire, so arranged that the stoking is done outside the building. There are eleven pot furnaces, varying in size from 16 in. to 24 in. square, for melting the various products. These, as usual here, are partially sunk in the ground, the fire bars and ash pits being below the floor level, with a sunk gangway along the front, covered by gratings for the removal of the ashes. Although this arrangement involves more work in cleaning up the furnaces after working, yet this is entirely outweighed by the greater facility which these furnaces afford for handling the pots and watching the melting, as compared with those built entirely above the floor level.

Some of these pot furnaces are now being supplanted by the erection of a pan reverberatory and a cupellation furnace for the Tavener method of dealing with the cyanide clean-up, which was referred to and briefly described in the article on the Bonanza Mine.

THE BATTERY GOLD.

The clean pressed amalgam from the battery is retorted and the bullion is merely melted down in plumbago crucibles and poured into ingot moulds to form bars of approximately 1,000 ounces each. The former practice of sampling the bars by drilling or chipping has been abandoned, a dip sample being now taken from each pot before pouring, and granulated by water in the customary manner.

REFINING KCy PRECIPITATES.

The gold slime from the clean-up press of the cyanide works is brought up in trays in its moist condition, and placed on a shelf in one of the calcining ovens, where it is dried first at a moderate heat and afterwards calcined on the floor of the oven. No nitre is used in this operation at this mine. The calcined material is then fluxed with the following mixture, the figures given being percentages reckoned on the weight of the dry slime :—

Sand, 20 per cent.

Fused borax, 50 per cent.

Carbonate of soda, 12 per cent.

The fluxed material is smelted in No. 70 clay-lined Salamander crucibles in the 18-in. furnaces, and poured into conical moulds. The lined crucible is preferred to the separate clay liners used at some mines on account of its greater capacity and a saving of heat. The conical buttons so obtained are melted a second time in No. 30 Salamander crucibles in the 16-in. furnaces, and run into 1,000-ounce bars, which average about 850 fine gold and 12 fine silver, in parts per thousand.

CHLORINATION GOLD.

The precipitated gold from the chlorination works is first hardened by boiling with sulphuric acid and steam, then washed with water to get rid of as much sulphuric acid as possible, and drained for a couple of hours before it is dried and calcined in the ovens. The calcined precipitate is melted in Salamander crucibles with 10 per cent. of fused borax, run into conical moulds, re-melted, and run into bars which are 980 fine or thereabouts. Practically, the only impurity in this gold is a small quantity of iron oxide which passes through the filters of the tanks in a very fine state of division when the gold-bearing solutions are drawn off from the leaching tanks to the precipitation tanks, and this is very slight unless the filters are in bad condition.

IMPROVED PERCENTAGE OF EXTRACTION.

The following particulars extracted from the various annual reports of this company show how greatly the total percentage of gold extraction has increased with the successive introduction of new methods.

Thus, in 1890, when amalgamation alone was employed, the actual gold recovery was only 70 per cent. of the ore value. Some of the remaining 30 per cent. was being stored in the concentrates and tailings, but it was not actually extracted.

In 1891 the mill returns increased to 71·04 per cent.; the gold in the vanner concentrates was 5·41 per cent., of which 95 per cent. was recovered by chlorination, which is equal to 5·14 per cent. of the ore value. The tailings and slimes, therefore, carried away 23·55 per cent., and the cyanide extraction at that date is stated at 73 per cent. But in working out these latter figures it has to be remembered that under the system of storing tailings in dams, probably not more than 55 per cent. of the tonnage crushed really underwent re-treatment, and the actual cyanide recovery was therefore only about 9·46 per cent. of the original ore value, and the total recovery from all sources was 85·64 per cent.

In 1894, when intermediate vats collected the tailings for direct treatment, the figures were: mill, 65·31 per cent.; chlorination, 9·41 per cent., and cyanide 10·61, or a total of 85·33 per cent. During this year the ore was almost all pyritic, and this accounts for the large decrease in the mill output, which was, however, almost compensated for by the greatly increased quantity of gold saved in the concentrates and by the slight improvement at the cyanide plant.

In 1896 slimes treatment was commenced, and the table below gives the results for the following years. The figures for the period since the war show some falling off because work has not been carried on under normal conditions, and also chiefly because slime treatment has not yet been resumed. It is also necessary to point out, to explain the chlorination figures for 1901 and 1902, that these works were not running in 1901, and all the concentrates then produced were treated and included in the return for 1902.

TABLE IV.

SHOWING PROGRESSIVE GOLD RECOVERY.

Year.	Mill Percentage of ore value.	Chlorination from Vanner concentrates. Percentage of ore value.	Cyanide		Total percentage recovery.
			Sands. Percentage of ore value.	Slimes. Percentage of ore value.	
1890	70	...	...	...	70
1891	71·04	5·14	9·46	...	85·64
1894	65·31	9·41	10·61	...	85·33
1897	60·86	7·22	16·47	4·72	89·27
1898	59·72	7·61	19·35	3·82	90·50
1899	65·01	5·09	18·43	3·24	91·77
1901	61·06	...	21·80	...	82·86
1902	59·03	8·72	21·37	...	89·12

ANALYSIS OF WORKING COST.

The following table gives analyses of costs for the years 1898 and 1902, before and after the war, and in the lowest line the total working cost per ton milled.

TABLE V.

	1898.		1902.	
	Per ton milled.	Per cent. of total.	Per ton milled.	Per cent of total.
	s. d.		s. d.	
Native labour ...	4 8·40	18·73	2 9·05	11·07
Native food	10·83	3·59	1 4·46	5·53
White labour and salaries	7 7·61	30·37	9 5·39	38·02
Coal, smithy coal, etc.	1 7·97	6·62	1 5·57	5·89
Dynamite	2 8·00	10·62	2 1·59	8·57
Fuse and detonators	1·61	0·54	1·19	0·40
Cyanide	4·50	1·49	7·92	2·65
Zinc	0·86	0·29	1·28	0·43
Mining timber ..	3·72	1·24	2·88	0·96
Deals, etc.	2·92	0·96	5·15	1·73
Drill steel	3·52	1·17	3·67	1·23
Steel, bars and plates	1·22	0·41	1·01	0·35
Oils, grease and paraffin	3·10	1·03	3·21	1·07
Candles	3·40	1·15	3·63	1·22
Ropes (steel and Manilla	0·54	0·17	0·72	0·25
Forage, chaff, bran, etc.	1·20	0·41	1·64	0·55
Electric spares ..	4·30	1·44	1·09	0·36
Mill spares (shoes and dies)	2·74	0·90	2·49	0·83
Mill spares (sundry)	3·96	1·31	1·17	0·39
Trucks, rails and wheels	2·16	0·71	1·66	0·56
Pumps, piping and fittings	3·50	1·16	2·60	0·87
Sundry stores, iron, etc.	2 1·49	8·44	2 5·12	9·77
General charges .	1 9·87	7·25	1 9·80	7·30
	25 1·72	100·00	24 10·20	100·00

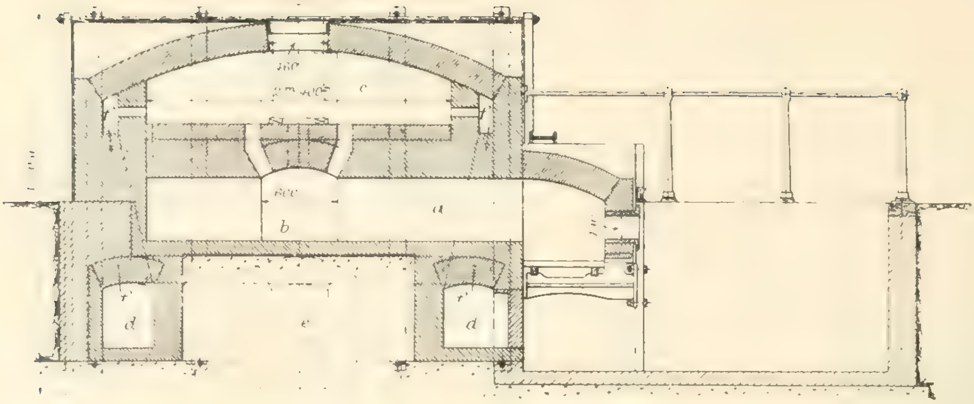


FIG. 31. LONGITUDINAL SECTION OF OVEN EMPLOYED FOR ANNEALING AND CEMENTATION.

SOME FOUNDRY PRACTICE AT SOTTEVILLE LOCOMOTIVE WORKS.

BY

CHARLES R. KING.

Concluding his description of the mechanical process for small foundry work carried on at the works of the French Western Railway at Sotteville, near Rouen, the author goes into the details connected with the various pattern casts for moulds and cores.—ED.

II.

IN my previous article on the multiple system employed by Messrs. Saillot and Vignerot, I described the special machines used at Sotteville for the rapid production of small pieces, such as those used for brake equipment, draft and buffing attachments, the lower halves of axle boxes, brackets, and wagon fittings in general. In the present article attention will be given to the stereotype casts.

PLASTER CASTS.

The casts serving for repetition moulding are generally plaster models, their exterior surfaces, when required for frequent use, being covered with a metallic sheathing which in foundry terms, is called a "coquille," and occasionally the model is itself a metal casting, or "stereo." As a rule, two distinct plaster casts are

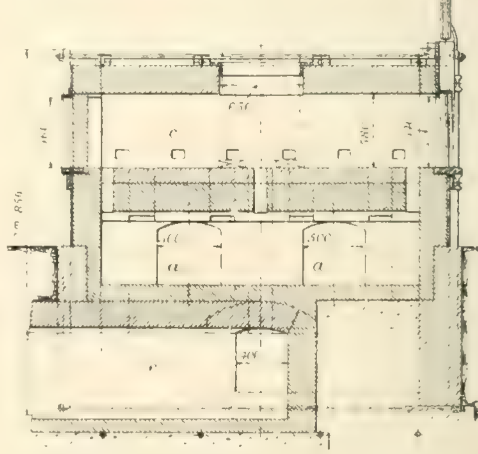


FIG. 32. TRANSVERSE SECTION OF OVEN.

In connection with this article and general foundry practice, it may interest readers who are making a study of the subject to know that two excellent books on modern foundry work have been recently published. One of them is entitled "Modern Iron Foundry Practice," by George R. Bale. Part I. deals with foundry equipments, materials used, and processes followed. Part II. is concerned with machine moulding and kindred subjects. It includes also chapters on physical testing shrinkage, and distortion of castings, the various methods adopted for cleaning castings, etc. The work is issued by the Technical Publishing Company, Manchester. Price 5s. each part.

The other book is entitled "Modern Foundry Practice," by John Sharp, with 272 illustrations. It deals with green-sand, dry-sand, and loam moulding processes, the materials used, also detailed description of the machinery and other appliances employed, with practical examples and rules. It is published by Messrs. E. and F. N. Spon. Price 21s. net.

Some Foundry Practice at Sotteville.

AXLE BOXES. MAKING CASTS FOR METAL SHEATHS AND FOR CORE-LIFTERS.

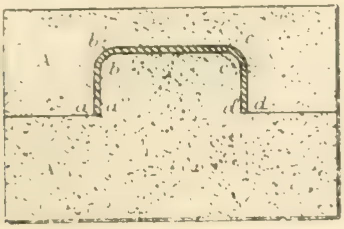


FIG. 15. Cast for Hollow Mould

A. Sand Mould from Wooden Pattern.
A'. Sand Mould from A.
The thickness of the Sheath is cut from A.
The Sheath, cast, is indicated by a, b, c, d, a', b', c', d'.

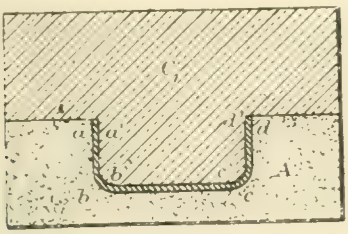


FIG. 16. Running of Plaster Cast.
A. Sand Mould from Wood Model.
C^1. Plaster Cast with adherent Sheath.

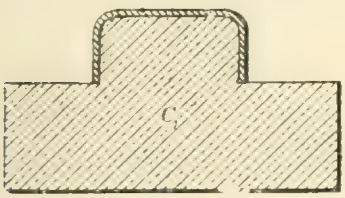


FIG. 17. C^1. Plaster Cast complete with Shell.

used each one corresponding, as usual, to one-half of the pattern, and these, moreover, can be repeateds everal times in a row upon the same cast. In the latter case the two halves of a given model may be placed side by side on the same cast, which thus suffices for both sides of a mould. These being identical, only need to be put together by reversing one of them upon the other. This work is more particularly described under the heading " Stereotypes."

In the following engravings, all scaled to the size of the round flask employed, are shown the means adopted for making casts for the oil reservoir, or lower half of the axle-box—a piece weighing about thirty pounds—and also for small fittings for buffer beams, weighing only nine pounds each.

The lower halves of axle-boxes being made in great quantites, the plaster cast for their moulding has to be covered with a metal sheathing. Figs. 15, 16, and 17 show the different operations in the making of the cast for the hollow mould. In fig. 15 are indicated the casts made for the sheaths, and in fig. 16 the plaster cast upon the sheath, while fig. 17 shows the entire cast covered with its metal sheath.

In figs. 18, 19, and 20 are depicted the successive operations for making the cast for the core. Fig. 18 represents the casting of the sheath in which an opening is formed for the core-lifter, or "depoussoir"; fig. 19 represents the pouring of the plaster cast, and in this same diagram are shown the flat slides, *t*, *t*, which serve to mould

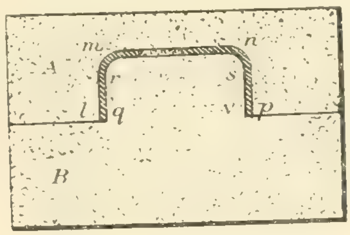


FIG. 18. Casting of Sheaths.
A. Sand Mould from Wood Model.
B. Sand Core moulded in the Core Box.
m, *n*, *r*, *s*. Thickness in sand for hole of Core-lifter.

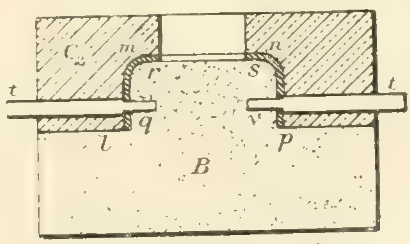


FIG. 19. Running Plaster Cast.
B. Sand Mould from Core Box.
C^2. Plaster Cast with adherent Sheath.
t, *t*. Moulding Slides.

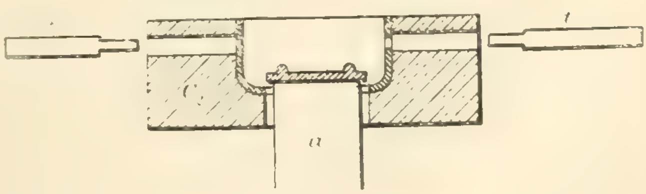


FIG. 20. Hollow Cast.
u. Core-lifter raised.

METHODS OF MAKING STRIPPING-PLATES OR RETAINERS (FOR DRAFT-BEAM FITTINGS).

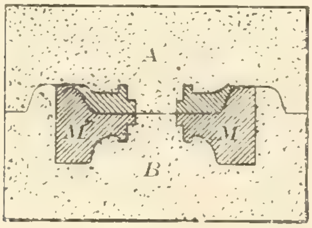
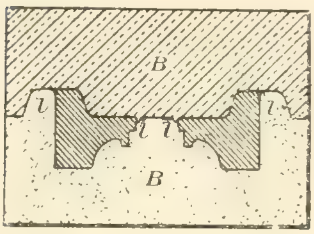


FIG. 21. Sand Moulding.
A, B. Sand Moulds from models M.



FIGS. 22 and 23. Impressions of Intermediary Plaster Casts
B. Underneath of Mould A, B.
B'. First Intermediary Cast with Profile l, l.

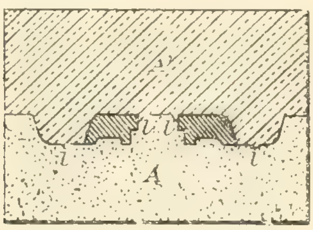


FIG. 23.
A. Top of Mould A, B.
A'. Second Intermediary Cast with Profile l, l

the horizontal ribs of the axle-box. It is necessary that these latter pieces should be adjustable to allow of the lifting of the mould; consequently the flat slides are moulded and cast apart and then fitted with care to the sheaths. The plaster cast is now run by placing the "coquille," or sheath, on the sand core, B (fig. 19), while the slides are slipped in to their openings and covered with talc in order that the plaster should not adhere to them. The hollow left in this cast for the core-lifter is also indicated in fig. 19. To make a core-lifter so that its form corresponds precisely with that of the sheath, the plaster cast is placed upon the core, and a core-lifter is cast therein with plaster, which thus takes the exact form of the hole which had been left in the plaster cast. The model so obtained serves for the making of a core-lifter in metal. Fig. 20 shows the cast for the core with the slides pulled out, and the core-lifter, U, raised.

Casting in "mottes," that is to say, in sand moulds lifted from the flasks that had served for their moulding, is employed whenever pieces have to be made in such quantities as would necessitate a considerable number of flasks.

The lifting or unflasking of the mould, termed "demottage," is effected, as has already been

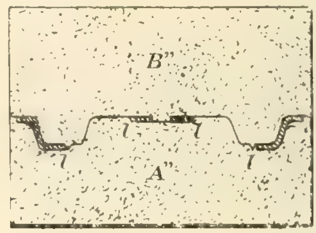


FIG. 24. Casting Retainers or Stripping Plates.
A'. Sand rammed on Cast, A, and thickness of Stripping-plate cut out at l, l.

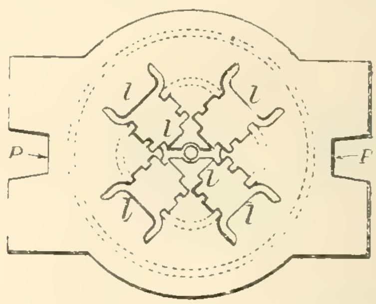


FIG. 25. Plan of Stripping-plate.
Showing line, l, l, where sand is cut out upon A".
P. Stripping-plate.

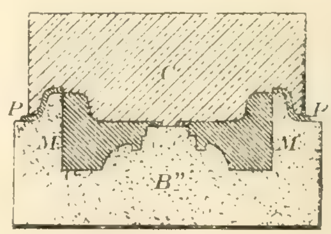


FIG. 26. Pouring Plaster Cast.
B". A Rapping from the Cast B', with the Models set upon the Cast (see fig. 12).
P. Stripping-plate.
C. Plaster Cast with adherent Models.

STEREOTYPE CASTS OR CLICHES.

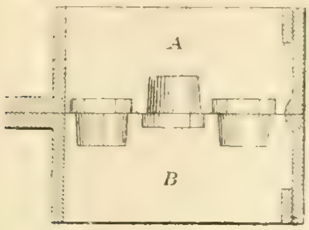


FIG. 27. Moulding in Sand.
A, B. Two-part Flask assembled for Moulding.

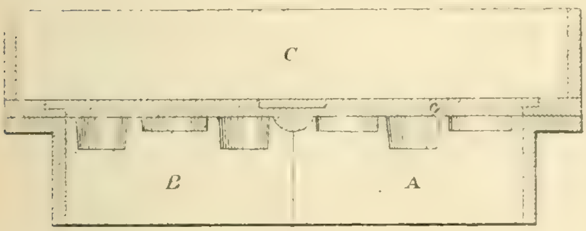


FIG. 28. Built-up Flask.
A, B. (Fig. 17) Twinned for Casting.
c. The Stereotype.
C. Flask filled with sand.

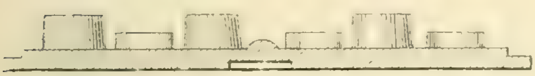


FIG. 29. Stereotype and Stereo-carrier ready for Moulding.

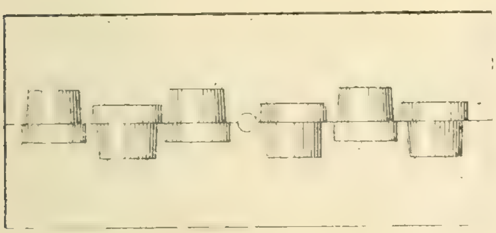


FIG. 30. The Three Models (fig. 17) give six pieces.

said, in the assembling machine, and to avoid bursting them during the pouring of the metal, a band of sheet iron, two millimetres thick, is hooped round the exterior surface during the process of moulding.

When there are, as is very commonly the case, a great number of little pieces to be cast, they are all grouped on the same plaster cast, gated together horizontally, and provided with one central runner in those cases where the moulds are superimposed. Stripping plates are used where one of the casts, such as is shown in figs. 21 and 26, has verital surfaces, and this in order not to be obliged to give the clearance necessary for withdrawing the mould. The stripping plates, or retainers, termed "peignes," support the sand of the mould during its removal from the cast. The stripping plate is mounted upon pillars secured to the platen of the moulding machine, and is thus raised along with the flasks. Figs. 21 to 25 show the different operations for making these plates, or "peignes." Fig. 26 shows the plaster cast, C, which carries that part of the model or pattern in which there are vertical surfaces requiring the use of a stripping plate, the latter being indicated at P. The plaster cast, C, is, of course, all in one piece with the metallic models, M.

STEREOTYPES.

Each metal stereotype, termed a "cliché," is really a turn-over cast obtained by the aid of special flasks. For moulding these in sand, two-part flasks, A and B (fig. 27), are employed, and the moulds, A and B, are assembled and poured together in the special frame (fig. 28). The mould, A, contains a certain number of the upper and lower halves of the same piece, and the mould, B, contains a corresponding number of upper and lower halves. For instance, A will contain two upper and one lower, and B two lower and one upper. The stereo, or cliché, C (fig. 28), thus obtained will have on the same plane three uppers and three lowers, and the mould will give six similar pieces. Several of these clichés are mounted in a carrier, termed a "porte-cliché," which is really a turn-over, or reversible cast (fig. 29). These stereos are so mounted in the stereo-carrier that once the two halves of the mould obtained from it are superimposed and assembled, the upper and lower halves of all the moulds will correspond exactly. A number of different stereos may be moulded in the same flask and gated horizontally, so as to give a great variety of castings. The alloy used for the casting of the metallic sheaths, stripping plates, and stereos, is a white metal composed as follows: tin, 42; lead, 42; antimony, 16.

The various qualities of sand for moulding are cut and mixed to suit the weight of the pieces that are to be cast, and in these mixtures bond

material is introduced in a somewhat large proportion. For small pieces the composition employed is one part new sand, two parts old sand, and an addition of 10 per cent. pulverised coal. For skin-dried mould, cores, and all baked work the mixture is one part new sand, one part old sand, with an addition of 20 per cent. horse manure. For large pieces moulded in the floor, the mixture is one-half of new sand and one-half of burnt sand, with an addition of 20 per cent. horse droppings and 5 per cent. of flock. The mixes adopted for the various castings are as follows: For propeller screws and engine cylinders—Viscaya pig, 23 per cent.; silicious cast iron and old cylinder scrap, 67 per cent. For ordinary pieces the proportions are as follows: Marnaval pig, 23 per cent.; silicious cast iron of 5 per cent. and old scrap, 67 per cent. For brake blocks as much as 10 per cent. of silicious cast iron is used to 90 per cent. of scrap.

Ordinarily, about twelve hours is allowed before lifting the pieces, and as the largest work done is not very thick, three or four days suffice for the cooling. Malleable castings are made by the ordinary mechanical processes, and annealed in the oven shown in figs. 31 to 33. This oven is employed not only for annealing, but also for cementation. It has been in use for a few years now, and is extremely regular in operation and very easily managed. It is of square form, and its furnace, which has three firing holes, is located in a pit to facilitate oven charging operations from the shop-floor level. This is shown in the section (fig. 31). The annealing chamber (or cementation oven) is indicated at C, and the hot air from the furnace is conducted there by parallel flues at A, intersected by a third passage at B, thence passing through a number of holes at the extremity of the two passages, A, and by other holes along the whole length of the passage, B.

From the oven the hot gases take a downward course, as indicated by the arrows passing into the two passages, *d*, which are connected by a third passage, E, discharging into the chimney, *g* (fig. 33), in which latter there is a register, *r*, for regulating the draught. It is to the large number of hot air holes in the oven that is due the special advantage acquired of almost imperceptible variations of air, which are inevitable with the opening of the fire doors; and the long course taken by the hot gases from the furnace to the chimney, in heating the masonry throughout their path, forms a sort of heat-balance in the apparatus. The oven requires no particular attention. During the night the fire is attended by the watchman, at 11 p.m. and 4 a.m., the temperature remaining almost constant at 1,000 deg. C. Ordinary castings are allowed about six days in the oven.

Cementation being largely practised for locomotive work in France, both for castings and forged pieces, this installation answers every requirement of the Sotteville shops. The cementing boxes are of cast iron, and of a width suitable for the usual run of pieces. The pieces put into the boxes are separated from each other by a layer of cement of about $1\frac{1}{2}$ in. to 2 in. deep. This latter consists of equal parts of charcoal and *savate*. After the top row has been so covered the box is filled up to the top with used cement, and then caulked with clay. Very good results are obtained, according to experience, with a depth of cementation very little more than 1 millimetre. This thickness is reached in about eight hours for pieces weighing up to 44 lb.—beyond which weight sixteen hours are required. The cementing boxes are manipulated by windlass, and a tank of running water is placed near at hand in which to plunge the box and contents.

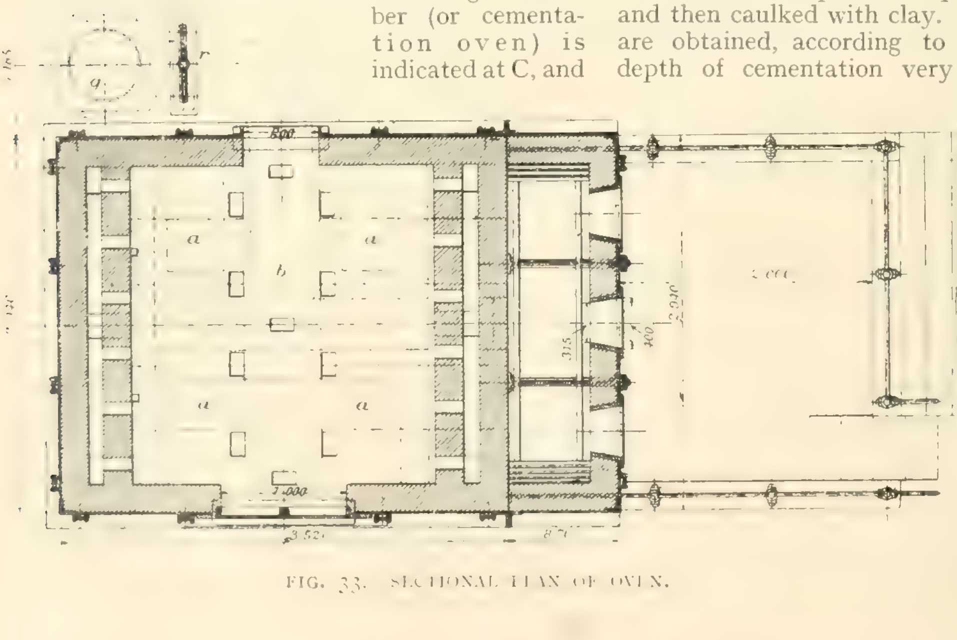


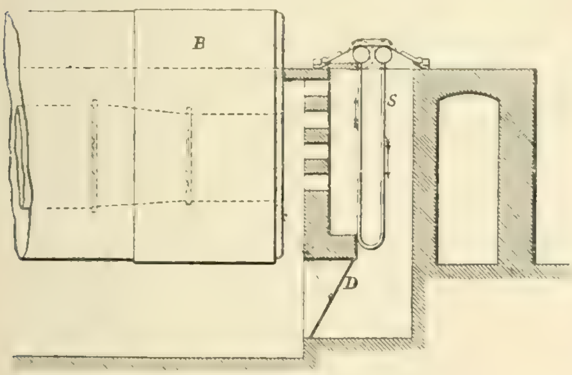
FIG. 33. SECTIONAL PLAN OF OVEN.

SOME RECENT SUPERHEATING EXPERIMENTS.

BY PROF. W. H. WATKINSON.

AN interesting sequel to the paper on "Some New Types of Superheaters," read before the Institution of Naval Architects, is a summary of tests made by Professor Watkinson at the works of Messrs. Mechan and Sons, of Glasgow, to determine the gain in power and the saving in steam and coal due to superheating.

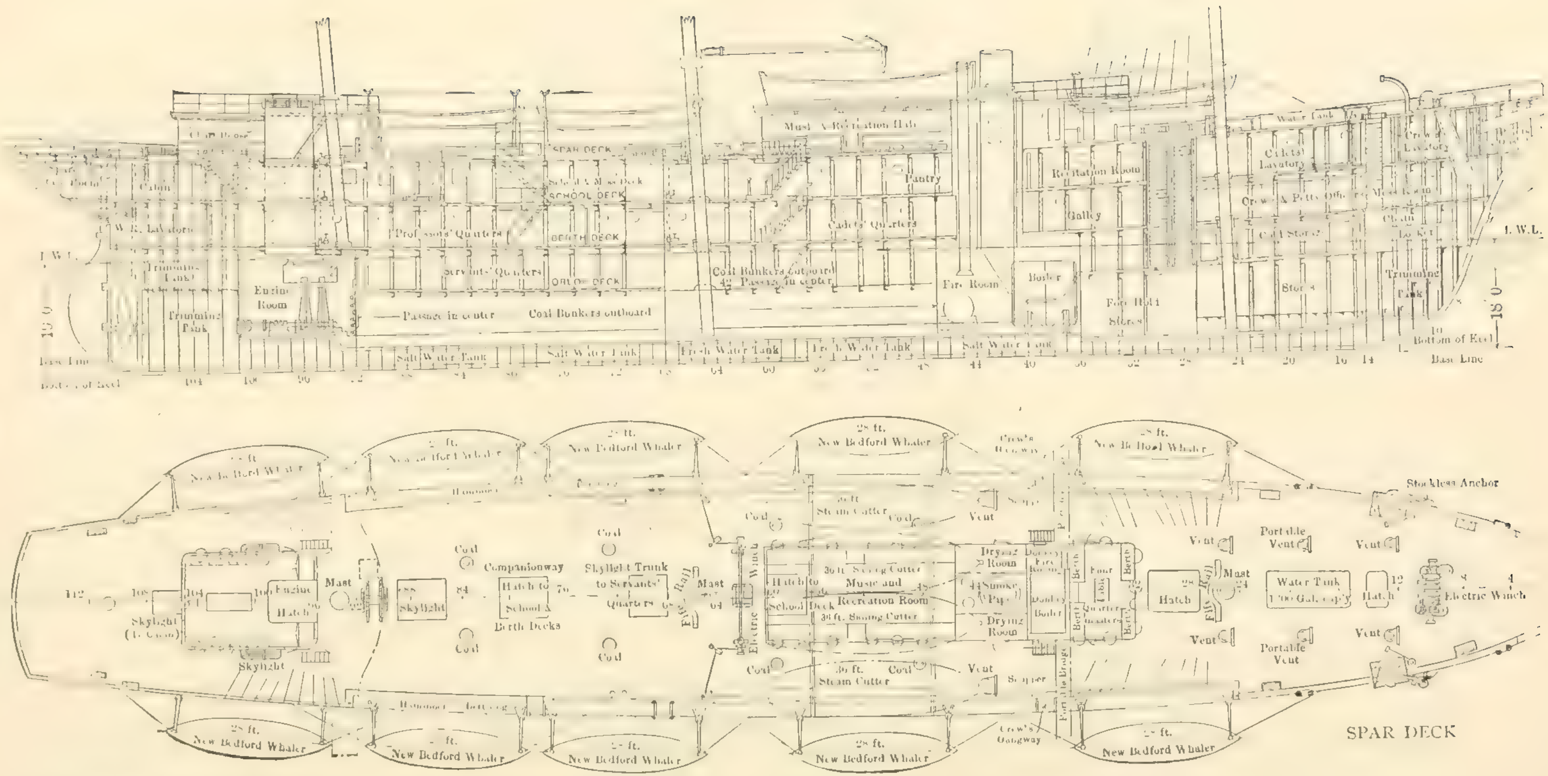
The arrangement of the superheater used during the tests is illustrated in the annexed figure. In describing it to the naval architects, Professor Watkinson remarked that "when superheaters are heated by products of combustion from boiler furnaces, it is well, wherever possible, to put the superheater in such a position that it will be acted upon by products of combustion at a temperature of 1,000 deg. F., or higher. In order to accomplish this in the case, for example, of Lancashire boilers, superheaters are sometimes put into the downtake chamber at the rear end of the boiler. When this is done, the tubes of the superheater inevitably become red-hot during steam raising, unless they are filled with water during this time." Some of the difficulties and dangers of this method of protecting the tubes were described. "With the object of obviating these difficulties, and



ARRANGEMENT OF SUPERHEATER.

in order that the degree to which the steam is superheated may be instantaneously regulated, the author devised the shunt-circuit system of supplying hot products of combustion to the superheater. The application of this system to a Lancashire boiler is here shown. B is the boiler, S the superheater, and D the regulating damper. During steam-raising, and whenever the engines are standing, the damper is closed, and the products of combustion all flow downwards to the bottom flue. When the damper is open, some of the products of combustion flow through the superheater chamber, and by adjusting the position of the damper, the degree to which the steam is superheated can be instantly regulated. The damper, being in a comparatively cool position, does not burn away." The following is a summary of the results of the tests, which, it will be noted, show a gain in power of 36·6 per cent., and a saving in coal of 27·4 per cent :—

	Saturated	Superheated
Date of trial	14 Aug., 1903.	15 Aug., 1903.
Duration of trial	7hr. 15min.	7hr. 5min.
Grate area	42·25 sq. ft.	42·25 sq. ft.
Kind of coal used	Earnoch Jewel Dross	
Cost of coal per ton, delivered at works	7s. 5d.	7s. 5d.
Total coal stoked during test, in lbs.	[illegible]	9,300
Weight of coal stoked per hour, in lbs.	1,324	1,313
Weight of coal stoked per hour per square feet of grate, in lbs.	31·4	31·1
Total weight of ash and clinker during trial, in lbs. ..	920	928
Weight of ash and clinker per hour, in lbs...	127	132
Weight of combustible, per hour, in lbs.	1,197	1,181
Total weight of feed-water during test, in lbs.	57,437	54,140
Weight of feed-water, per hour, in lbs.	7,923	7,643
Temperature of feed-water, average	105° F.	107° F.
Pressure of steam, by gauge, average, lbs.	98	103
Temperature, corresponding to pressure	336·5° F.	339° F.
Temperature of steam leaving superheater, average ..	—	492·5° F.
Temperature of steam at engines, average	331° F.	470° F.
Degree of superheat at superheater	—	153·5° F.
Degree of superheat at engines..	—	131° F.
Length of steam pipe between superheater and engines ..	87 ft.	87 ft.
Weight of water evaporated under actual conditions per lb. of coal stoked, in lbs. ..	5·98	5·82
Weight of water evaporated from and at 212° F. per lb. of coal stoked, in lbs.	6·31	6·56
Weight of water evaporated under actual conditions per lb. of combustible, in lbs. ..	6·61	6·46
Weight of water evaporated from and at 212° F., per lb. of combustible, in lbs. ..	6·97	7·30
Heat utilised per lb. of combustible (assuming the steam leaving boiler to be dry), in British thermal units ..	6,753	7,099
Electrical horse-power during test, average	176·2	240·8
Gain in power due to superheating	—	36·6%
Consumption of steam per electrical horse-power hour, in lbs.:	44·0	31·7
Consumption of coal per electrical horse-power hour, in lbs ..	7·51	5·45
Saving in steam, due to superheating	—	27·3%
Saving in coal, due to superheating	—	27·4%



By the courtesy of "Marine Engineering."

INBOARD PROFILE AND SPAR DECK PLAN OF THE "YOUNG AMERICA."

A FLOATING COLLEGE FOR ENGINEERING AND OTHER STUDENTS.

IN a recent number of PAGE'S MAGAZINE we referred to the training ship *Young America*, which embraces one of the latest schemes of nautical training devised in the United States, its object being to supplement a first-class preparatory education with world-wide travel, and such knowledge of nautical matters as will be of use to students who are likely to be engaged in after life in any enterprise in which ships and commerce are involved. For the accompanying plans, as well as for the following particulars, we are indebted to *Marine Engineering*.

The complete four years' course will include cruises to all of the principal countries in the world, and the calendar is so arranged that each cruise will be in a temperate climate and along the most approved routes for the avoidance of stormy weather. Students may be enrolled for from one to four years, while the term comprises nine months, from September to June. Opportunities will be given for going ashore and visiting the cities and points of interest along the route. Instruction will also be given in navigation and steam engineering. The school is planned on strictly naval lines, the cadets being formed into companies, and the companies divided into sections to be under the personal supervision of the professors. Cadet officers will be appointed after the first month on the basis of merit in studies and deportment; the first month they will be appointed by lot. The religious and physical training will be properly cared for, and the health of those on board will be under the charge of a regular physician.

The propelling engine consists of a vertical inverted direct-acting compound engine with high-pressure cylinder 22 in. and low-pressure 44 in. in diameter, the stroke of both pistons being 24 in. When making ninety revolutions, the indicated horse power at 100 lb. steam pressure will be about 500. The engine is mounted on cast-iron bed, with condenser in the back columns of the engine, and the front of the engine will be supported by wrought-iron columns. An auxiliary condenser is placed in the fire room, and both will have combined air and circulating pumps. Each cylinder is fitted with a liner, and the high-pressure has a valve of the piston type, 8½ in. in diameter, and the low-pressure has a slide valve. Both cylinders will be steam jacketed round the liners and at the top covers. The pistons are of cast iron, the rods of forged steel 3½ in. in diameter, and the crossheads of forged steel; the slipper will be of cast iron with 132 square inches for forward surface, and 100 square inches of backing surface. The connecting rod tapers from 3¼ in. at the upper end to 3½ in. at the lower end. The valves are operated by the Stephenson link motion, the eccentrics and eccentric straps being of cast iron and the rods of forged steel. Reversing is accomplished by a steam cylinder 8 in. in diameter by 16-in. stroke, fitted with floating lever and a locking device.

The crank shaft is of forged steel with the slabs shrunk on. The propeller and thrust shafts are also forged steel, 8½ in. diameter, made in one piece, that part of the shaft passing through the stern tube being fitted with a composition casing. The stern tube will consist of an iron or steel pipe flanged at the inboard and threaded at the outboard end. The propeller will be cast iron.

The boilers are Scotch marine type built according to the rules of the United States Boiler inspectors. The tubes are 7 ft. long in the clear, 2½ in. external diameter. The smokestack will be about 50 ft. high above grates, the upper 15 ft. of it being made telescopic, with proper means for raising, lowering, and guiding same. The donkey boiler is placed forward on the berth deck, built for 100 lb. steam pressure. The pumps are the following sizes:—

Feed pump, 4 in., 10 by 10 in., vertical double acting.

Donkey feed, 10 in., 7 by 10 in., vertical double acting.

Circulating pump.

Fresh-water pump, 4½ in., 6 by 6 in., vertical double acting.

Brine and evaporator, 4 in., 2½ by 6 in.

Deck, fire and bilge, 12 in., 10 by 12 in., vertical double acting.

Engine room, fire and bilge, 10 in., 7 by 12 in.

Main air and circulating.

Auxiliary boiler, feed, 3½ in., 2½ by 4 in.

An evaporator of 4,300 gallons of potable water in twenty-four hours will be installed, also two distillers, each condensing 2,000 gallons of water in twenty-four hours. The ship will be heated with steam throughout.

The vessel is being built by the Perth Amboy Shipbuilding Company for the Nautical Preparatory School.

THE IRON AND STEEL INSTITUTE.

An Account of the Autumn Meeting at Barrow-in-Furness.*

It is probable that the autumn meeting of the Iron and Steel Institute at Barrow will be one of the most memorable recorded in the annals of the society. The unique personality of the President —Mr. Andrew Carnegie— was thrown heart and soul into the meeting; the papers read were in several instances of more than ordinary interest, and the *locus in quo* of the gathering was eminently desirable, whether considered as a centre of industry or a starting point for pleasant excursions. Deluges of rain, which somewhat interfered with the out-door proceedings, were the only drawback connected with the meeting, which extended over four days—September 1st, 2nd, 3rd and 4th—and was attended by nearly five hundred members. The decoration of many of the public streets and buildings showed that interest in the conference was generally shared by the people of Barrow.

THE RECEPTION.

The proceedings commenced with the reception of the President, Council and Members of the Institute in the Town Hall, by the Mayor of Barrow-in-Furness (James Fisher, Esq.), and by the Chairman and members of the Reception Committee.

Among those present on the platform were Sir James Kitson, M.P., Sir W. Lewis, Sir B. Samuelson, Sir David Dale, Mr. Victor Cavendish, M.P., Sir E. H. Carbutt, Mr. William Whitwell, Mr. E. Windsor Richards, Mr. E. P. Martin, Mr. George Ainsworth, Mr. Arthur Cooper, Mr. David Evans, Mr. Arthur Keen, Mr. G. J. Snelus, Mr. J. E. Stead, Mr. R. A. Hadfield, Mr. Tannett-Walker, Mr. James M. While, Mr. Price Williams, Mr. J. C. Ridley, Mr. John M. Gledhill, Mr. Illtyd Williams, Mr. A. Helder, M.P., and Mr Bennett H. Brough (Secretary).

The Mayor, in the course of a short address, sketched the rise and growth of Barrow, remarking that they were now a community of between 60,000 and 70,000 essentially working-class people, whose existence depended to a very large extent, if not wholly, upon the iron and steel industry and shipbuilding. The Iron and Steel Institute and the town of Barrow were very closely linked together through the late noble Duke of Devonshire—who was the first president, and who did so much to promote the iron and steel industries of Barrow—the late Sir James Ramsden, and the late Lord Frederick Cavendish, both the latter having been vice-presidents. Having regard to the great rapidity with which Barrow had grown, he hoped the members would not be disappointed in their public and private buildings, or in their educational or industrial developments. Their most recent efforts in the direction of education were crowned the previous week by the presence of her Royal Highness Princess Louise, who opened their technical schools, which had been built at a cost of £30,000. He concluded by expressing the satisfaction which was felt by the people of Barrow at this their second visit to the town.

Colonel Vickers, in the unavoidable absence of the Duke of Devonshire (Chairman of the Reception Committee), also extended a hearty welcome to the members on behalf of the manufacturers of the district.

MR. CARNEGIE AND BARROW.

The President briefly replied. A great transformation had come over Barrow since he last visited it. Early in the seventies he came to the place to see what he could learn concerning the latest developments in the manufacture of steel. In America they had paid Barrow the most flattering tribute of imitation. Barrow had been their exemplar—their model. In the seventies it was merely a straggling village; now it was a prosperous town, with a fine technical school, a free library, and working men's clubs, with fine broad streets, lined with trees. In the course of further remarks Mr. Carnegie said they came to Barrow as the cradle of the institute, which was founded on noble lines. All the progress that had been made in iron and steel by men who had made improvements was openly laid before the institute, where there was a free exchange of ideas for the benefit of all.

PRESIDENTIAL ADDRESS.

The business of the conference then commenced, and the President, on rising to deliver his address, was greeted with prolonged cheering. The address was as follows:—

It is twenty-nine years since the institute held its autumn meeting at Barrow. I have recently looked over the proceedings of that notable meeting. These seem to carry us back almost to the very beginning of cheap Bessemer steel manufacture in America, in

* See also the Outdoor Programme, page 307.

which as usual Britain was the pioneer and taught the younger Republic. It was at that meeting your fellow-member and Bessemer medallist, Alexander Lyman Holley, then our engineer from the Carnegie Steel Works, read the two papers which first brought to your attention the doings of your American brethren in developing the Bessemer process you had given them.

ENGLAND PIONEERS THE STEEL INDUSTRY—AMERICA DEVELOPS IT.

There are several here to-day who were then present. Such was the impression made upon the meeting that after the discussion, in proposing a vote of thanks, our Nestor, Sir Lowthian Bell, as President, said, " There was no doubt that in America they were doing great things in the manufacture of Bessemer steel, and their friends on the other side of the Atlantic were not averse to telling them what they did, and not only what they did, but how they did it. He thought, under the circumstances, if any member of that institute was entitled to the thanks of the meeting it was the gentleman who had just read the last two papers."

The effect of these papers, as you know, is a matter of history. Mr. Josiah T. Smith, of Barrow, one of the greatest of your managers, and subsequently president of the institute, characteristically said that Mr. Holley would find that, as far as Barrow was concerned, " They would try and do as well, in regard to quantity, as the United States," which struck the right note. There spoke the true Briton, who has done according to his means more than any other, the American not excepted. The record of the great little mother of nations is not equalled by any of her children, although her oldest and biggest seems to inherit his mother's indomitable spirit and the ability to work miracles. In all matters of iron and steel, however, the child has been borne upon the shoulders of the parent. If the Atlantic Ocean had been prairie land, there would have been little left in the world but the conquering old lady and her family, all under one roof, under one flag—a self-sustaining Empire under Free Trade, with probably two hundred millions of our English-speaking race, and a home market so big as to give control of neutral markets. No question of Protection or preferential tariffs then to disturb us ; besides all this, we should have been able to enforce peace among nations. It would have been a case of Britain *versus* all the rest of the world, the world kicking the beam.

WHY NOT RE-UNION?

Gentlemen, unfortunately an ocean exists where we should have preferred prairies, but it is traversed in about the same time as the three thousand miles of land between Montreal or New York on the Atlantic, and San Francisco and Victoria on the Pacific. Who so bold as to predict that never is our race to succeed in converting the ocean, hitherto a barrier to your extension, into the pathway to re-union of the two once united branches ? Not I ! My faith is unshakable that some day this will be accomplished, and that, instead of being two small islands here alien to the European Continent, you will look across the sea to your own children in Canada and the United States, and become once more the mother member of the dominant power of the world.

Mr. Whitwell participated in the discussion, and asked Mr. Holley to give his opinion on the " from one-half to three-quarters more product which could be got from the converter in America than we were getting in England," which Mr. Holley answered after reading his second paper. It was chiefly owing to his own invention of bottoms in reserve and removable appliances.

A CONTRAST IN PRODUCTION!!!

There was also at this historical meeting a report, a remarkable production, submitted by David Forbes, Foreign Secretary to the Institute, upon the progress of iron and steel industries in foreign countries. I naturally turned to see what he had to say about the United States. Several pages are given to the Pittsburg district, and what is there recorded carries me back to the days of youth apparently. In 1873 the Pennsylvania Steel Company made 20,000 tons of steel rails. They make that amount in two weeks now. Bethlehem Iron Works were engaged in raising a loan of the enormous amount of £20,000 for the extension of their works, a paltry 100,000 dollars. Five millions would be comparatively less to-day. The great Cambria Iron Works in Western Pennsylvania, near Pittsburg, were credited with having made no less than 1,027½ tons of ingots in the week ending September 26th, the largest quantity ever made in a week—a day's work nowadays. Two new blast furnaces were being built in Ohio, the capital of the company being all Scotch, and it was proposed to call the iron Scotch-American pig. This isn't a bad brand—either of men or iron. It is noted that the total production of pig iron in the United States in 1872 was 2,897,000 net tons, and in 1873 just about the same ; to-day it is approaching 20,000,000 tons per annum. The product of steel, nearly 15,000,000 tons, is greater than the rest of the world.

BRITISH AND GERMAN PROGRESS.

The progress of Germany and Britain have also been great. Britain made 643,317 tons of steel in 1874, and last year 4,909,000 tons. Germany made 361,946 tons in 1874, last year 6,394,000. In 1874 Britain made 6,054,000 tons of pig iron, Germany 1,906,000 tons. Last year they made 8,517,693 and 8,403,000 tons respectively. In 1874 the world was producing nearly 14,000,000 tons of pig iron and 280,000,000 tons of coal. Now there is being produced 41,000,000 tons of pig iron and 780,000,000 tons of coal.

Another item—Mr. Forbes is informed that for the last seven months natural gas has been utilised in Pittsburg in one of the mills. The largest output for a furnace then known was during the week ending September 7th, 1874—702½ tons, 100 tons per day. When our Lucy furnace made 100 tons in one day, the world thought the limit was surely reached. Two new Carnegie

furnaces have recently averaged [illegible] tons each per day for months at a time.

Records are given of various enterprises which promised brilliant results, but which are already things of the past. Perhaps the most noticeable point of all is that not the slightest mention is made of the Carnegie Steel Company—so much a thing of yesterday it is. It was making iron and building bridges and had also furnaces in operation, which were visited by the late Thomas Whitwell, but it was scarcely worth noticing, as its steel works were then only under construction. So rapidly do things grow in the new land !

STEEL AT THREE POUNDS FOR A PENNY.

You have noticed that the blast-furnace product increased more than six times, and also the rail-mill's product about the same. The work of a week is now done in a day, but great as is that contrast, here is one still greater. There have been made and sold without loss hundreds of thousands of tons of 4-in. steel billets at three pounds for *a penny*. Surely, gentlemen, the limit has been reached here. I think it has, and it is doubtful if ever a lower price can be reached for steel. On the contrary, there is every indication that period after period the price of steel is to become dearer owing to the lack of raw materials. To make that three pounds of steel, at least ten pounds of material were required—three pounds of coke, mined and transported sixty miles to the works, one and one-half pounds of lime, mined and transported one hundred and fifty miles, and four and one-half pounds of ironstone, mined at Lake Superior, and transported nine hundred miles to Pittsburg, being transferred twice, once from cars into the ship, and again from the ship into the railway cars. How it was done, I cannot pretend to tell you, but I know the figures are correct. But every time I repeat them, I doubt their possibility. This was done during the day of depression, when everything was at the lowest. Costs are several dollars per ton higher to-day, during this period of boom in America.

THE FUTURE—A QUESTION OF SUPPLY.

Gentlemen, such is the contrast between 1874 and 1903. What is it to be twenty-nine years hence ? What changes are to come ? I have tried to imagine some of its features. It is scarcely possible that this country can increase its product of iron and steel materially. Let us hope that the product will not be decreased. The vital element in the matter is, as we all know, the supply of iron ore. Many of you are conversant with the situation here. I only know what I learn from others, but undoubtedly the attention of the iron and steel manufacturers should be directed to this question—Where and how can they obtain a supply of iron ore ?

Nor is it a question which the manufacturer of America can safely neglect. It was because it forced itself so strongly upon us that we secured such an abundant supply of the best ore obtainable. For sixty years, I think, the United States Steel Corporation is supplied at its present rate of consumption, but sixty years is as nothing in the life of a nation. It is upon future discoveries of iron ore that the future of cheap steel manufacturing, even in America, depends. There are immense deposits in now inaccessible parts. In Utah, for instance, and in Southern California, large deposits have been found, so that steel will continue to be manufactured, but it would not surprise me if its cost was very greatly advanced in the future. It seems almost miraculous that such an article as steel could be produced and sold without loss at three pounds for *a penny*. I am convinced that this is a thing of the past. It will be a question of increased cost and therefore of increased price, so that neither Britain nor America need fear that steel manufacture will be wholly lost ; the world will gladly pay the increased price necessary to obtain it. During the next half century, it seems that America is to increase her output at a tremendous pace. The output of Britain will perhaps remain stationary or even increase somewhat if developments in Norway and Sweden prove satisfactory.

Gentlemen, even if this Barrow meeting should fail to rank in importance historically with the first one, I am sure that in the warmth of welcome received, in the enjoyment of the occasion and in the meeting of one with another, the records will not fail to show that 1903 compared favourably even with its epoch-making predecessor.

ALLOYS OF IRON AND TUNGSTEN.

Mr. R. A. Hadfield then presented a comprehensive paper of sixty-eight pages on "Alloys of Iron and Tungsten." The following synopsis will serve to indicate its scope.

PART I. (*Historical data*).—Origin of the name, discovery, and early history of the metal. Ores of tungsten, their description and sources. Properties and preparation of pure tungsten. Production of the metal tungsten and ferro-tungsten. Early history of tungsten alloys and tungsten steel.

PART II. (*Physical data relating to tungsten and its iron alloys*).—The metal tungsten. Production of the author's specimens. Cast tungsten—iron alloys. Appearance of fracture. Bending tests. Forged tungsten-iron alloys. Appearance of fracture. Bending tests. Elastic limit. Tensile strength. Elongation and reduction of area. Water-quenching and bending tests. Compression tests.

This present paper on the effect of tungsten added to iron is a continuation of the same line of research adopted by the author in relation to the effect of different elements, including manganese, silicon, aluminium, chromium, and nickel, added to iron.

The fluctuations in the price of tungsten ore are very extraordinary. Among the countries supplying it are Austro-Hungary, Spain, Portugal, Brazil, Queensland, New Zealand, and Canada. Though much of the ore passes through English hands, it is stated that the chief market is Hamburg, where about six hundred tons are sold annually. The Tungsten Company states that there are two main classes of wolfram ore, one of which is a tung-state of iron with more or less manganese and alumina replacing the iron ; the other, scheelite, which is tung-state of lime. Wolfram ore, as a rule, contains from 65 per cent. to 70 per cent. WO_3, while scheelite runs a little higher, say from 68 per cent. to 75 per cent. Wolfram is,

however, preferable to scheelite for the manufacture of pure tungsten.

The yearly output of ore is difficult to estimate, but probably over 1,200 tons are used annually, which is equivalent to about half that weight of manufactured tungsten in one shape or another. *Mineral Industry* (1901) estimated the production of the ore for 1899 at about two hundred tons, which is probably too small.

As is well known, tungsten has been used for many years in the manufacture of self-hardening steel, that is, steel which could be rendered hard enough to keep a cutting edge by means of heat treatment and without subsequent water-quenching. If such steel was dipped in water whilst red-hot it would split or crack. The tungsten percentage in such steel has usually been between 5 and 8 per cent., carbon 1·50 to 2·30 per cent.

For many years in Sheffield the addition of tungsten used in the production of "self-hardening" steel has been by the oxide or by means of a metallic powder, though owing to more recent improvements in the manufacture of the ferro alloy and the metal itself, this form is just coming into general use. As regards addition by means of metallic powder, this, although supposed to be in the metallic form, often contains considerable quantities of carbon, as well as oxide, not reduced, or only imperfectly so, and it is for this reason, no doubt, that the production of uniform qualities of tungsten steel has in the past been so uncertain. More regularity is now obtainable by means of the ferro-tungsten alloy, that is, an alloy in which there is a considerable percentage of iron, 1 to 4 per cent. of carbon, with a comparatively small percentage of manganese, and tungsten varying from 30 to 80 per cent.

Iron-tungsten alloys do not appear to show the peculiar exception found in nickel and manganese steels. They conform to the general rule that increasing quantities of an element added to an alloy already brittle do not restore the toughness.

Hardness of the cast specimens.—For the same reason the alloys appear to gradually increase in hardness.

Magnetic susceptibility of the cast specimens.—Here, again, unlike alloys of iron-manganese and iron-nickel, there is no falling-off or decrease in the magnetic qualities by increasing additions of tungsten.

The discovery and utilisation of tungsten has occupied the attention of many minds. As far as we can tell, we are chiefly indebted to that little band of Swedish investigators, Cronstedt, Scheele, and Bergman, to each of whom the world owes so much, for the earliest research work upon it. Coming to more recent times, in the fifties of last century, we find Jacob and Koeller in Austria, as well as Oxland and David Mushet in England, specially studied this interesting metal, its qualities and its employment in connection with the manufacture of steel. Still later, were Osborn, of Sheffield, Holloway and also Biermann, of Hanover. Blair and Bedford, of Sheffield, have contributed interesting knowledge, and in America, Greene and Wahl. Osmond, by his cooling curves, has brought several peculiar points in the thermal behaviour of this steel, and Barrett has discovered that tungsten affects the conductivity of iron less than any other added element. Still later, Taylor and White, of Bethlehem, have added to our knowledge in the same direction.

Though tungsten-iron alloys will have an important future, there is no doubt that, so far as can be seen at the present time, their use is not likely to be on the same large scale as some of the other special steels now produced.

Annealing considerably toughens the cast material. Attention is specially drawn to the fact that, unlike either iron-manganese or iron-nickel alloys, there is apparently no point where the maximum brittleness is reached and afterwards a return of toughness. In the two former steels there is a zone of brittleness, and, with further higher additions, a return to toughness.

As the tungsten increases there is a gradual diminution of toughness, and the angle through which the bars bend decreases with the increase of tungsten.

Mr. Harbord, in the course of a brief discussion, referred to some unpublished results of experiments he had made with alloys of tungsten in Bessemer steel some time previously, the tungsten ranging from ·01 to 1·05 per cent. His results confirmed those of Mr. Hadfield.

Mr. Stead pointed out the large and promising field of investigation opened up to metallurgists in following the effects of tungsten as an alloy to iron. As illustrating the enormous field of inquiry opened up in the manufacture of steel, he exhibited some specimens in which remarkable results had been obtained by heat treatment. In one piece, of uniform chemical composition, he had obtained, by varying degrees of heating and cooling, what were practically six different kinds of steel.

The President, in referring to the international character of the membership of the institute, pointed out that in Mr. Hadfield's paper the results of investigators representing every civilised country were combined. The good resulting from this pooling of the scientific labours of the world could hardly be overestimated.

DANGEROUSLY CRYSTALLINE STEEL.

A joint paper by Messrs. J. E. Stead, F.R.S., and A. W. Richards, Middlesbrough, dealt with "The Restoration of Dangerously Crystalline Steel by Heat Treatment."

Mr. Stead, before reading the paper, said he wished to correct an erroneous statement which had appeared in the Press. It had been stated that he had made some discoveries which were revolutionary. The facts he was about to set forth were not in any degree revolutionary. It was needful to say this, because some uneasiness had been caused in regard to plant and machinery being rendered obsolete.

The following is a brief abstract of the paper :—

In the course of our experience we have met with steel dangerously crystalline which may for convenience be divided into three classes.

The first class occurs only in mild steel very low in carbon and in pure iron ; it is caused by annealing for a long period at too low a temperature in a slightly oxidising atmosphere.

The second class, which is equally dangerously crystalline and is very common, is produced by long-continued heating at high temperatures.

The third variety occasionally met with is produced by heating the steel till it is practically burnt. In other words, to a point so near fusion that an evolution of gas occurs in the interior of the steel which separates the crystals from each other, so breaking up or making more or less discontinuous the whole mass.

The metal in the third class, although greatly improved by heat treatment, can never be thoroughly

restored by simply heating it ; but in the case of the steel of the first and second classes we have found no difficulty, by proper heat treatment, in making it equal and more often superior to the normal or forged steel which had been worked and finished at proper temperatures.

The authors proceed to give at considerable length details of experiments made on rails, and also gave particulars of some tests made with 5-in. steel blooms. The question of resistance to repeated alternations of stress is also dealt with, the following conclusions being arrived at :—

In reviewing our work, we believe that the following facts have been firmly established :—

1. The microscope in each experimental series indicates the same result, that heating at high temperatures causes a great development in the size of the crystalline grains, and reheating to about 870 deg. restores the original or a better structure.

2. If all structural steels in their normal rolled or forged condition are good, they can be readily deteriorated in quality by heating to a temperature a little above that to which steel is most commonly heated previous to rolling or forging.

3. Steel made brittle by such heating and dangerously brittle by heating at considerably higher temperatures, can be completely restored to the best possible condition without forging down to a smaller size or by remelting.

Practically, all our results show that not only are the original good qualities of normally rolled steel, after making brittle, restored by the exceedingly simple treatment of heating to about 900 deg. C. for a very short time, but that such steel is made considerably better than it was.

It is scarcely necessary to say how important and far reaching to steel workers and engineers this most valuable knowledge is.

That brittle "soft steel" can be restored by reheating has been proved by one of us, and confirmed by Professor Heyn, Mr. Ridsdale, and is well known in Sweden, but that carbon steels can be actually made much superior to the original properly forged metal by reheating to 870 deg. C. and cooling in air is revealed at this meeting for the first time. It will be remembered that one of us at the Düsseldorf meeting last year urged upon those to whom it might concern the imperative necessity of reheating to 900 deg. C. all forgings, and allowing them to cool in the air to remove accidental brittleness. The results given in this paper fully justify the statements then made. We would further urge that in every large forge and smith's shop Le Chatelier pyrometers should be introduced, and, in addition, suitable furnaces for reheating the forgings, and that these should be systematically made use of.

From our own somewhat extensive experience we know for a fact that in many works steel is forged, rolled, and finished at temperatures far above what is the best for the endurance of the steel when put into practical use, and we feel confident that if such appliances were to be intelligently employed the finished forgings would be greatly improved. It must be acknowledged that it has been upon the inferior enduring properties of such material that engineers have had to base their factors of safety, with the inevitable consequence that on the average much greater margins have been allowed than would be necessary if the steel were invariably obtained in its maximum condition of strength and safety.

We are sanguine enough to believe that, as research advances, that enviable goal will ultimately be reached.

The work presented is certainly a movement in that direction, but we hope that by treating steel so as to obtain in it a large proportion of sorbite, still nearer shall we be to the highest aim of the metallurgist of iron and steel. We aim at making material which will be twice or three times as enduring as that commonly made to-day, and we believe that we shall be able eventually to make it.

4. We are convinced that the system often specified by engineers that forgings when being annealed shall not be heated to a temperature high enough to cause a scale, is wrong ; 870 deg. C. is coincident with a blue scale, and the steel is improved by heating till it forms this scale.

5. When the forgings are of unequal section they may be heated to 850 deg. C. to 900 deg. C., and be then cooled in air, be oil quenched, or be treated by any other sorbyising process till they are a barely visible red, and finally annealed in a furnace at a dull red heat to remove the stresses produced by rapid cooling.

The meeting adjourned on the understanding that the paper on dangerously crystalline steel would be discussed in conjunction with a contribution on sorbitic steel rails by the same authors, and other papers.

WEDNESDAY.

Mr. Stead said he had remarked on the previous day that all brittle steel could be restored. He wished to qualify that by saying that all *good* brittle steel could be restored. Here there was a great difference, because he did not wish to leave the impression that steel still brittle in consequence of the large quantity of impurities it contained could be restored by reheating in the way described. He was told that it was all very well for him to treat small samples in a small way. How, he was asked, were manufacturers to heat to the proper temperature large masses of shafts from end to end ; how could they get a furnace to do that ? His answer was that they were in a progressive age, and had got to do it. They knew it was difficult to get regularity of temperature, but he was sure their engineering skill was quite sufficient to overcome the difficulty

SORBITIC STEEL RAILS.

The following is an abstract of Messrs. Stead and Richard's paper on "Sorbitic Steel Rails" :—

From a physico-chemical point of view, there is not a great difference between pearlite and sorbite. But sorbite may be obtained side by side with pearlite by hastening the cooling without quenching, or by quenching a steel just at the end of the critical interval, or again, by reheating a quenched steel to about the same critical interval. For all these reasons sorbite may be considered as pearlite which has not been able to separate into ferrite and cementite by reason of lack of time, or from some other cause, and it seems to be true that it ought to contain a little more "hardening" carbon than free pearlite.

This particular condition, or variable condition of the carbides in iron and steel, had never previously had a term given it, although it has nevertheless marked properties and distinct microscopic features, and can be readily detected in steel containing it. So distinctive are the properties which it confers on steel that for years it has been the practice of steel manufacturers, at considerable expense, to oil-quench heated steel in order to obtain increased toughness and strength, and for wire manufacturers to patent

their wire rods to arrive at a similar result. It is the sorbite produced which confers greater tenacity and toughness to the steels.

In order to ascertain the relative wearing property of pearlite and sorbite steels, we would have been glad if we could have presented actual results of wear on a permanent railway track over a period of several years. As this was, however, impossible, we endeavoured to get some indications by other means. The method we finally adopted was that of grinding on a freestone grindstone, using equal surface pressure and distance travelled. In applying this test, we cut out pieces from the heads of both the rails ½ in. in thickness and 1 in. square. These were carefully weighed, and were pressed on the surface of the revolving grindstone by a weight of 72 lb. until they had travelled a distance of 20,000 ft. They were then removed and weighed. The tests were repeatedly made on the same pieces. The results are as follows :—

	Average.
Pearlite rails	0·10
Sorbite rails	0·33

The results are decidedly in favour of the sorbite rails. Whether or not they will be borne out in practice remains to be seen. It seems most reasonable to believe that such homogeneous material as the sorbite steel, much tougher than the same steel in the pearlite condition, will certainly last much longer on the permanent way.

The chief point of interest in our work is the simple method employed for producing sorbite in steel. The usual custom has been to reheat and oil-harden or to quench completely in water and reheat to dull redness. In our method we avoid reheating, and quench the heads of the rails, as soon as they are sawn to length, to a point under Ar 1, and allow the residual heat in the rails to do the tempering. The results of the later experiments show clearly enough that by partially quenching the heads and allowing the rails to temper themselves, although the elongation is decreased, the contraction of area remains practically the same.

Finally, we may point out that although it is quite easy to treat hot rails in short pieces, we have not yet completely succeeded in treating 30 ft. lengths satisfactorily. Our work is, however, far from complete, but we hope that before long we shall be able to report a complete success.

Mr. A. W. Richards, in the course of some supplementary remarks, said they considered what all forgings, rolled axles, etc., should before being sent out for use, be reheated, to split up any gross crystallisation there might be present. They were also of the opinion that shafts, axles, etc., that had been in use a number of years, and other steels subjected to constant vibration, became in time fatigued, and often became brittle, and if taken out, say, every ten years, and simply heated to about 870 deg. C. for half an hour, and cooled out slowly, it would materially increase, if not double, their lives, and would prevent many of those mysterious breakdowns of steels they so often heard about, which were difficult to account for, and would be the means of preventing accidents on sea and land, which often involved fatal results.

Mr. T. Westgarth alluded to the conservative attitude of their workmen to these experiments. Mr. Stead had spoken of the difficulty of devising a suitable furnace for proper reheating, which must be done properly and regularly to be useful. He was now designing with Mr. Stead a suitable furnace. They had already determined to adopt this in their works, and, perhaps, at some future time they might be able to give some details of the results of the process. The principal point was the method that Mr. Stead and Mr. Richards adopted. It seemed to him that the method of Messrs. Stead and Richards for testing by a constant reversal of strain was almost ideal. It was very easily done by means of the rotary method they had adopted. The results obtained by the rotary method of testing, which was the nearest possible way of testing by continually reversing the strains, was admirable, and this more nearly approached the actual conditions under which they used the materials.

Mr. C. H. Ridsdale, in the course of further discussion, remarked that as regards restoration of spoiled steel, no sweeping statement could be justified. In many cases, steel, the structure of which had been rendered either very coarse (by heat treatment of some form in excess), or which had become very fine, or in state of strain (through work at too low temperature), was completely restored to at least as good as in its normal state by simple rapid reheating up to cherry redness (say 850 deg. to 950 deg. C.), and then keeping at that temperature for from a minute to, say, fifteen, according to the size of the piece. Even a higher temperature, as 1,000 deg. to 1,100 deg. C., did not undo the good done if the time was correspondingly shortened. He believed he was the first to emphasise the desirability of the reheating being rapid, and it was, therefore, interesting to note that the rail A 4, which was rapidly reheated to 1,100 deg. C. had given the best results.

Further discussion was contributed to by Mr. E. F. Lange (Manchester), Mr. Price Williams (London), Mr. L. N. Ledingham, Professor T. Turner (Birmingham University), and Mr. R. A. Hadfield.

THE PROBABILITY OF IRON ORE LYING BELOW THE DUDDON ESTUARY.

Mr. James L. Shaw contributed a paper on the above subject, of which the following is an abstract :—

There was no doubt that there might be large deposits of iron below the sands, and the facts quoted were in the direction of supporting the assumption that these deposits are great in body as well as of good quality. The sands had been comparatively little tried with the boring-rod, but in some cases ore of workable thickness had been found. The paper discussed the probability of the position of ore from a geological point of view, the facts brought forward being illustrated by diagrams giving sections of the ground. The author considered that the whole of an untried area of limestone between two faults which were discovered was likely ground for carrying large bodies of ore. The paper concluded with a short description of what the author considered the best method of boring, advocating the use of a stage above high-water. From this the men could work two and even three shifts in the twenty-four hours, access probably being best gained by an electric pinnace, and one capable of towing a barge with material would be very desirable.

COAL AS FUEL AT BARROW.

This was the title of a paper by Mr. W. F. Pettigrew. An abstract follows:

Although boring for coal has at various times been carried out at Barrow-in-Furness, up to the present time none has been found, although some are confident that the same beds which are being worked at Whitehaven run through this district.

At the present time coal is obtained from Cumberland, Lancashire, and Yorkshire (West and South). As the prices at the pit, the cost of carriage, and the quality of the coal from these districts vary considerably, the author has carried out several experiments to find the relative value of coal obtained from the districts before mentioned, also from various parts of Scotland and South Wales.

The information was required principally for fuel for locomotive engines, and it was with one of these the experiments were carried out.

The best results were given by the sample of Yorkshire. This coal has excellent steaming qualities, is very clean, with an open clinker, and low percentage of ash.

The Welsh coal was also good when tried, and equal in all respects to the Yorkshire coal above mentioned, and would no doubt give even better results if properly fired, which was not so during the trials, the men having had practically no experience with this kind of coal.

The Cumberland coal was good, particularly one sample, but this was not found suitable for locomotive purposes. The other sample of Cumberland coal gave fairly good results, but is a dirty coal, and necessitates the frequent cleaning of fires.

The Lancashire samples were in some cases very good steaming coals, with a moderately low consumption, but several samples gave very bad results, and were quite unfit for locomotive purposes.

The Scotch coals tested were fairly good, but in most cases a very heavy consumption was recorded. They are quick burning coals, and dirty, but with an open clinker which did not interfere in any way with the steaming. The consumption was from 20 to 40 per cent. higher than the Yorkshire coal. This, combined with the heavy cost of carriage, made it quite impossible to adopt them.

The paper included many valuable diagrams and tables.

THURSDAY.

THE DISEASES OF STEEL.

The proceedings opened with a discussion of Mr. Ridsdale's paper on "Diseases of Steel."

It is impossible in the space at our disposal to give a satisfactory abstract of this paper, which is packed with valuable data, and should be obtained and filed for reference. It is systematically arranged, as follows: —

Part. I. Faults originated during manufacture traced *forward*.

- Sec. I. General observations.
- Sec. II. Irregularities whilst making the semi-product.
- Sec. III. Irregularities whilst working up the semi-product.

Part II. Types of faults and manifestations traced *backward*.

- Sec. IV. Enumeration and consideration in detail.
- Sec. V. Systematic scheme for identifying and tracing to their origin.
- Sec. VI. General notes as to determining the means of prevention and cure, and concluding remarks.

The paper refers primarily to "soft steel" (*not* of any particular make, but common to all usual types) of from a trace up to 0·20 per cent. of carbon, and although much that is said may be true of higher carbon steels, the remarks must be accepted guardedly for these.

Although the results of treatment, contrary to its nature, are not diseases of steel, but injuries to it, yet as the distinction is not always clear till tested, they have been included under the same head.

An attempt has been made to collate various types of faults and manifestations, to append briefly some of the main data known as to their peculiarities, and to present them in a form handy for reference, also to show how they may be traced to their origin. The scheme is offered tentatively, with the knowledge that as time goes on it will need revision, and new tests added.

The investigation has been pushed from both ends; *forward* by synthetical *reproduction* of *known* irregularities of manufacture, and observing the results; *backward* from the manifestation of the disease by tests and reasoning till its unknown cause is detected.

The tests are by no means chemical only, but also suitable mechanical and physical tests, examination with the microscope, etc., and where a simple practical test will answer it is better than a more elaborate one.

Mr. S. E. Stead intimated that to discuss the paper adequately ten whole days' continuous sitting would be required. He did not believe steel had many diseases; there were ailments which might be readily cured. He might say, when engineers made their specifications, in justice to them it must be remembered that they made them with the object of getting material of the very safest character, and he would like to confirm what he had already said, and what Mr. Ridsdale had said, that it was quite possible for a steel containing high impurities properly treated to be better than the very purest material improperly treated. But for engineering work he thought there could be no doubt that the less impurities in the steel the better it would be, and if it were properly heated and forged pure steel would be better than those containing the higher amount of impurities.

Prof. Turner, in the course of further discussion, said he felt that they were very much indebted to Mr. Ridsdale for his attempt to put on a scientific basis the method of investigating these troubles of steel, and he might say iron as well, because much that has been said with reference to steel would also apply to iron.

The President remarked that their distinguished fellow-member (Mr. Stead) had suggested "ailments" of steel, but he would like to suggest that Mr. Stead had not got the right word yet, and it should be "mysteries" of steel. He could not pass a bar of steel without doing so reverently, because in that little particle there were, perhaps, some of the mysteries of human life. They were on the threshold of fresh discoveries, and he wished that he could be made immortal, with Mr. Ridsdale and Mr. Stead, so that he might learn something of the diseases, the ailments, and the mysteries of steel.

THE REGULATION OF COMBUSTION IN COKE OVEN PRACTICE.

Mr. D. A. Louis contributed an interesting paper on "The Regulation of Combustion in Coke Oven Practice."

The author deals first with the historical aspect of coke oven practice. He remarks that he has followed the coking practice in many centres, but in none so keenly as last year in Westphalia, where a great many collieries, widely distributed over the field, were visited, and at all the collieries inspected vertical-flued ovens were in use, and the particular models adopted were, in the preponderating number of cases, the Otto-Hoffmann, or the more recent form of Otto oven without the regenerating chambers, with or without by-product saving, and indeed they seemed to give satisfaction, and maintain their popularity. But this popularity does not go unchallenged, for although the ovens contemporary with the Otto have not made headway in the competition, other ovens of new design enter into the lists and bid for public favour. At the present time the ovens due to the ingenuity of Dr. Theodor von Bauer and those elaborated by Mr. Franz Brunck are the most prominent competitors in this field. Both these made a more or less modest display at the Düsseldorf Exhibition, where their more successful rival was represented by a more imposing and highly creditable exhibit.

The paper gives a detailed description of the Brunck system and Bauer's coke oven, with diagrams. On no colliery visited by the author were the Brunck ovens in use, although he says there were a good many about.

At the Hannover III. Colliery the working of the Bauer oven was particularly interesting, inasmuch as there were also a number of Otto ovens coking the same coal at this colliery; this gave an opportunity of making a comparison, and, as far as that coal was concerned, the von Bauer oven acquitted itself with distinction. The fifty Otto ovens, according to the foreman, were producing 130 tons of coke in the twenty-four hours, giving a yield of 69 to 70 per cent. of the coal; the thirty-four von Bauer ovens were producing 170 tons of coke in twenty-four hours with a yield of 73 to 74 per cent. of the coal; moreover, the von Bauer was a denser coke. In both cases the gas and heat not consumed in the ovens was being used under boilers, and the von Bauer was again showing to advantage. This would seem to show, what would be anticipated, that there really is some virtue in having the gas and air supply well under control and well distributed in the firing flues, for these were the most striking features in these ovens, coupled with the localising and distributing the temperature, for these, like the Semet-Solvay ovens, have two complete sets of flues to each oven.

OTHER PAPERS.

Other papers included "The Heat Treatment of Steel," by Mr. William Campbell; "The Burning and Overheating of Steel," by Mr. Alfred Stansfield; "Notes on the Manufacture of Weldless Steel Pipes and Shells," by Mr. H. Ehrhardt, of Düsseldorf; a paper by Prof. Baker dealing with the "Influence of Silicon on Iron," and summarising investigations made by the author at University College, Sheffield; "Notes on the Heat Treatment of Steel Rails high in Manganese," by Mr. J. S. Lloyd; and "Some Further Experiments on the Diffusion of Sulphide through Steel," by Mr. E. D. Campbell.

VOTES OF THANKS.

In addition to the usual votes of thanks, special resolutions were passed acknowledging the services to the Conference of Mr. Victor Cavendish and Mr. A. Aslett, the general manager of the Furness Railway Company.

Mr. T. Ashbury (Manchester) moved a vote of thanks to the President. They had had a most pleasant meeting, and had been ruled with a dexterity and skill which they all admired.

Mr. Kirchoff seconded. He said that a short time ago a committee was formed in America to arrange for a second visit of the Iron and Steel Institute; and he had the pleasure of being the spokesman of that committee, which hoped that in the fall of next year they would pay them a visit. He had brought with him a series of letters endorsing this invitation from the leading engineering societies of America: the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Franklin Institute of Philadelphia, the Foundrymen's Association of the United States, and others. Together they represented about 10,000 very busy men, who would join them in pledging the Institute that they would do everything in their power to make their visit profitable, and a pleasant one. They hoped to be able to take proper care of the members and their ladies. They hoped to interest them, and they trusted that their guests would be generous to them in the one thing that was most precious to them all—their greatest possession—and that was their time. They must come to stay as long as they possibly could.

The President: You have had your invitation acted upon, and carried unanimously. It is accepted. I seem to live in a strange kind of atmosphere. I received the Iron and Steel Institute as chairman of the committee in New York. Little did I dream that I would be transformed—shall we say reformed—from an American into the President of the Iron and Steel Institute, and now, as your officer, I am to be received by those Americans in my position of British President. That seems to be most appropriate, because on this island I first drew the breath of life, and I spent my manhood and boyhood across the Atlantic, and they are to me the same. I find no inconsistency in being loyal to both.

In the course of further remarks the President said that all they wanted to do to be friends with Americans was to know them. He referred with satisfaction to the number of brilliant young men in the Institute who were coming to the front.

An account of the excursions, &c., will be found in another part of the MAGAZINE.

The Suggested Forth and Clyde Ship Canal.

BY

BENJAMIN TAYLOR, F.R.G.S.

A survey of the rival schemes for the construction of a deep-water ship canal between the Forth and the Clyde—a project revived by the creation of the new Naval Base at St. Margaret's Hope.—Ed.

LARGE and various interests are affected, and numerous considerations are raised, by the Government's decision to establish a new naval station on the Firth of Forth at St. Margaret's Hope. The project has been for long in progress. It dates back to Mr. Goschen's time, so the Admiralty and the Government have been in no hurry. St. Margaret's Hope has been chosen as the new site for strategic and other considerations, and it is to be known as Rosyth. It has advantages which no competing place has. It is close to the coal and iron fields of Scotland; it is remote from industrial centres, and therefore is not subject to inflation in the value of land; it affords a splendid anchorage, already strongly fortified. The extent of the ground which is required for the scheme necessitates an expenditure of something like £125,000. The land is valuable, but not so much so as if it had been immediately adjacent to a large town.

The development implies a great transformation of the district, even if there be no dockyard, and if St. Margaret's Hope, or Rosyth, is reserved exclusively for the purposes of a naval base. Portsmouth, Chatham, and Devonport are all naval bases and also dockyard towns. Haulbowline and Pembroke are not bases, but only naval workshops. A great naval dockyard will be, sooner or later, required in the Forth or the Clyde, though at present the construction of one in the Forth is not proposed. The area of land required should be sufficient to give future scope for any necessary expansion for the building of ships.

The naval base itself means a great deal, and Rosyth will take its place beside Portsmouth, Chatham, and Devonport. It will be furnished with complete resources for turning out a proportion of the Fleet in time of war. There will be stores, barracks for marines, engineers' workshops for the execution of repairs, and all the requisites of a depot ready to be drawn upon by His Majesty's ships when engaged in active service. It will be a large and busy centre of naval life even in time of peace, for the bases now in existence do not provide sufficient accommodation for ships lying up, and there is no other in the north.

THE SITE AND ITS ASSOCIATIONS.

St. Margaret's Hope, which is to the west of North Queensferry, on the north side of the Forth, is full of historic associations. An old keep which stood on Inchgarvie, and which dates back to the days of James IV., has recently been transformed into a modern fort, and mounted with guns. On the Battery Hill, where the old boatman lived in the days of Sir Jonathan Oldbuck, is now an apparatus connected with the search-light. Guns are mounted on the forts on the highest points on the north and south sides of the river The Hope anchorage is situated immediately to the west of the Forth Bridge. The river narrows at the Bridge to less than two miles, while in the Hope it widens out to about four miles, and has always been a retreat for vessels in time of storms. It has often been the anchorage for fleets visiting the Forth. The bay itself is named after Queen Margaret, of pious memory. In 1069, Margaret, sister of Edgar Atheling, and her mother and sisters and brother, were driven by stress of weather into the Firth of Forth on the occasion of their flight from William the Conqueror. Their vessel came to anchor in the Bay, and the exiles landed on the promontory on which Rosyth Castle now stands. The Bay in time took the name of St. Margaret's Hope, and the ferry has long been known as "The Queen's Ferry." The exiles went on to Dunfermline, and were hospitably entertained by Malcolm Canmore, in Dunfermline Tower, in the grounds of Pittencrieff, which have recently been acquired by Mr. Andrew Carnegie.

North Queensferry was a place of considerable activity when the ferry was the highway between the North and Edinburgh, but since the Forth Bridge was built the village has become merely a summer resort.

Inverkeithing had once a fleet of vessels, but the old Ness pier, which was once the scene of much activity, is now a total wreck, and the shipbuilding and engineering works which stood at the mouth of the Keithing are now silent. The Naval Base will change the whole aspect of affairs in the district.

RESOURCES FOR COALING.

Coal has been worked in the "Kingdom" of Fife since 1290 (though the discovery of navigation or steam coal is only of recent date), and the two lowest and most important seams are hard and flinty, well adapted for shipping and household purposes. In a pit at Kelty, sunk nine years ago, it was found that the splint and the five-feet seams yield a splendid steam or navigation coal. At Glencraig and at Bowhill Collieries, navigation coal has also been discovered, and pits are being sunk elsewhere in pursuit of the same seams. The discovery of steam coal has raised the output of the county from 3,706,467 tons, in 1896, to 6,134,137 tons, in 1902.

THE PROPOSED SHIP CANAL.

The creation of this new Naval Base has revived a project which was much discussed some twelve or fifteen years ago for constructing a deep-water ship canal from the Forth to the Clyde. When the matter was brought before the House of Commons by Mr. James Caldwell recently, Sir Fortescue Flannery said there was no doubt that the existing dockyards were congested. He believed that they ought to relieve the dockyards by an additional base and not by reducing the naval preparations. The suggestion of Mr. Caldwell was worthy of the careful consideration of the Admiralty, namely, that the new base in the Forth should be connected with the great shipyards of the Clyde and Belfast by means of a canal across the country. That proposal was not then put forward for the first time, but he called the attention of the Admiralty specially to the fact that the access round the North of Scotland was one of the most dangerous and difficult navigations that could possibly be made in the neighbourhood of the British Isles, and, therefore, if at anything like a reasonable cost this connection could possibly be made, the strategic advantages would be in proportion to the disadvantages and the expenditure which would otherwise be involved.

COMMERCIAL ASPECTS.

In shipping and commercial circles the greatest interest has been aroused by the proposed construction of a deep-water canal connecting the Forth with the Clyde, and adapted for the passage of the largest mercantile steamers. A syndicate has already been formed for the complete survey of the routes. The existence of such a waterway would lead to the creation of a large revenue from the merchant tonnage coming from the Baltic. Shipowners appreciate the extent to which the dangers of steaming round the Pentland Firth would thus be avoided, not to speak of the great saving of time. A large trade might be developed with the port of Glasgow in respect of the direct importation, without breaking bulk, of produce from the Baltic ports, and from Holland. Produce from these quarters has at present to be shipped *via* London, Hull, and other ports on the eastern seaboard. As to the naval aspect of the question, the whole subject has been under consideration for several years past, and the consideration has been deepened by the development of the French project for a ship canal between the Atlantic and Mediterranean coasts of France.

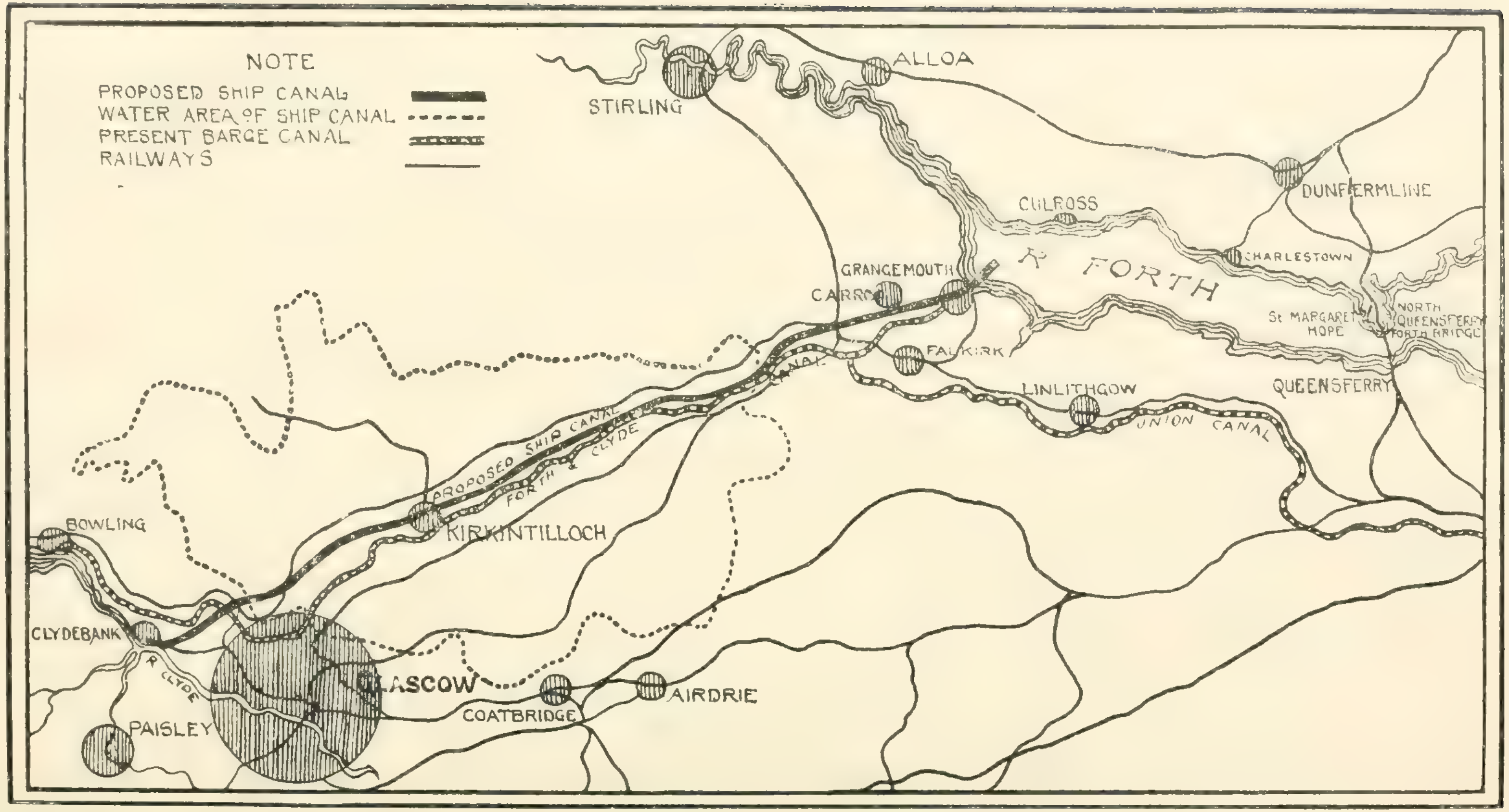
It is said that Charles II. favoured an expenditure of half a million in cutting a waterway across Scotland for transports and war vessels from east to west. How far half a million would have gone in his day we need not estimate, for that sum would hardly do a tenth part of what is needed now.

THE EXISTING CANAL.

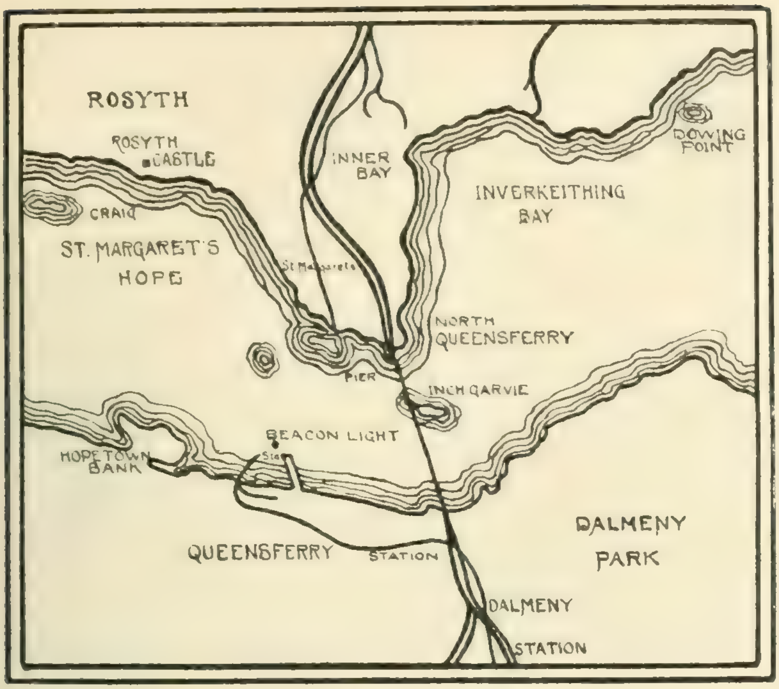
The existing Forth and Clyde barge Canal is the oldest undertaking of the kind in Scotland. It was designed by Smeaton, with the assistance of Brindley. Its construction commenced in 1768, and after many years of constant toil it was opened throughout for traffic in 1790. The work proved of a very arduous description. Rocks, precipices, and quicksands had to be dealt with, and deep mosses had to be traversed. At some points the canal was banked twenty feet high, while it had also to be carried across rivulets and roads, and over two streams of considerable size—the Luggie and the Kelvin. The length of this canal, from the first lock on the Forth to the last lock before the Clyde can be reached, is thirty-five miles, but when the cutting to Glasgow and the junction between Port Dundas and Monkland Canal basin are taken in account, the total distance traversed by the canal extends to about thirty-nine miles. The rise from the Forth to the summit-level is 156 ft., and the descent to the Clyde at Bowling Bay amounts to 150 ft. The water width at surface is 56 ft., and at bottom 27 ft. The depth was originally 8 ft., but the banks were afterwards raised so as to afford a depth of 10 ft. From the first this canal has been attended with a fair amount of financial success. By 1800—ten years after the opening—the Canal Company had not only cleared off a loan advanced by the Government, but were able to pay a dividend of ten per cent. This, in 1815, rose to twenty per cent., which was the highest dividend declared. The dividend settled to six per cent., at which figure it remained until 1876, when the Caledonian Railway Company acquired the canal by paying the shareholders a fixed guaranteed interest of six and a quarter per cent. A curious ceremony marked the opening of this canal. On July 29th, 1790, the magistrates of Glasgow made a voyage from the Forth along the new canal, and, on their arrival at its junction with the Clyde, poured into that river a hogshead of water brought from the Forth. Thus were the two rivers united, amid the cheers of the assembled multitudes.

AVAILABLE ROUTES.

There are now two definite schemes before the world in connection with the new naval base. One scheme is what is called the Direct Route, with



FORTH AND CLYDE SHIP CANAL—SKETCH MAP OF DIRECT ROUTE.



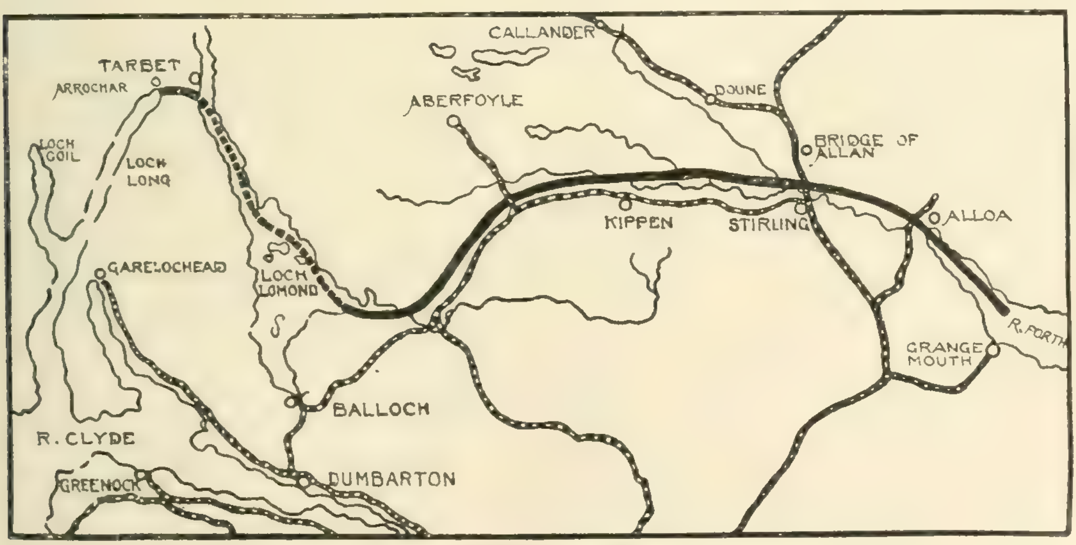
SITE OF THE FORTH NAVAL BASE.

which the name of Mr. J. Law Crawford is specially associated. For this it is claimed that the canal would traverse one of the most extensive coal-fields in Great Britain, with one-half of the unwrought coal in Scotland adjacent to its eastern entrance. The seams are mostly of steam coal, and steamers using the canal would be able to coal practically at the pit's mouth, and save the cost of carriage on their fuel.

THE DIRECT ROUTE.

The Direct Canal (leaving the river Clyde between Clydebank and Yoker, some few miles below Glasgow) would run in an easterly direction partly along the line of the existing Forth and Clyde Canal, and partly along the valley of the Rivers Kelvin, Bonny, and Carron. It would reach the Forth just at the mouth of the last-named river, near Grangemouth, a few miles south-west of St. Margaret's Hope anchorage, or Rosyth naval station.

Upon this plan the Ship Canal would be an artificial waterway rather under thirty miles in length. It would have a bottom width of 100 ft.; a depth of 26 ft.; and a surface width varying according to locality, but nowhere less than 126 ft. There would be six locks at each end of this canal, and the engineers propose that these locks should be double; one part 600 ft. long and 65 ft. wide; the other 400 ft. long and 40 ft. wide, for smaller craft. The first lock, eastward from the Clyde, would have a lift of 10 ft. above ordinary highwater mark; and the next five locks, all occurring within four or five miles, would have a lift of 16 ft. each, raising to the summit-level. This level runs continuously for $17\frac{1}{2}$ miles, at the end of which the first of the eastern locks is encountered, five of



SKETCH MAP OF THE LOCH LOMOND ROUTE SHIP CANAL.

which have an aggregate lift of 85 ft. from the ordinary high-water mark of the Forth. The fifth lock would be at Larbert, and admit vessels into the River Carron, which would be canalised. The sixth eastern lock would be a tidal lock at the end of the canal, admitting to the Forth. This plan involves the crossing of six railways, and at two of these crossings swing-bridges would be necessary. The present Forth and Clyde Barge Canal would also have to be crossed, and a considerable number of roads. But it is contended that no serious physical or engineering difficulties would occur, and that there is abundant water supply from the streams on the summit-level. The question of cost, of course, is important. It has been estimated that the cutting of the Direct Route Canal, the construction of locks, the forming of railway and other crossings, reservoirs, etc., will require about six millions sterling. The land required is valued at a million, and, allowing another million for margin, would give a maximum total estimate of eight millions sterling.

THE LOCH LOMOND ROUTE.

Another scheme is that of Messrs. D. and T. Stevenson, engineers, and is what is known as the Loch Lomond Route. This route is advocated by a syndicate which is now making the necessary surveys.

It is proposed on this plan to drive a cutting from the Forth, near Grangemouth, past Stirling, and along the line of the Forth and Clyde Railway to the River Endrick, and then by that water to Loch Lomond. This cutting would be some thirty-two miles in length. Practically, this would be through the valley of the Forth, in which, up to within ten miles of Loch Lomond, the ground does not rise more than from thirty to fifty feet above sea-level, and is alluvial. On entering Loch Lomond, vessels of the largest size would find ample depth and sea room, and it is proposed to canalise the Loch—much as the lakes on the Suez Canal—up to Tarbet, a well-known resting-place on the Queen of Scottish lakes. From Tarbet, a short canal of about a mile and three-quarters would have to be cut, through ground reaching a maximum height of 130 ft. above mean sea-level, to Arrochar, on Loch Long. Loch Long is a sea loch—a portion of the Firth of Clyde, and, therefore, practically the Atlantic Ocean. It has great depth of water, and, being sheltered by high mountains, presents an easy navigable run of several miles down to the wide-spreading Firth.

The first part of this route lies along the Forth valley. The tract of country from Alloa westwards to within about ten miles of Loch Lomond is only from 30 ft. to 50 ft. above the mean sea-level, and the strata, as has been said, is an alluvial deposit. Thereafter the ground rises rapidly, and attains a maximum height of 240 ft. above mean sea level, and dips again to the south end of Loch Lomond, the surface of which is only 22 ft. above mean sea-level. The distance across the higher ground is about seven miles, 1¾ miles of it being above the 200 ft. line. Loch Lomond could be utilised as the canal towards the north end of the Loch to Tarbet, and thence across to Loch Long there is only a distance of 1¾ miles. The surface of Loch Lomond, 22 ft. above the mean level of the sea, is the proposed summit level of the canal, and, having a water area of 21,000 acres and ample gathering ground, it would form a reservoir for supplying the locks with water.

FEATURES OF THE LOCH LOMOND SCHEME.

Only two locks, one at Alloa and one at Loch Long, would be required, as the level of the canal is only 13 ft. and 17 ft. above high-water level at these places, respectively. Both approaches are in smooth water, and free from any danger to navigation. The western outlet into Loch Long is considered advantageous, as vessels of the largest class could at once proceed to sea quite free from interruption or liability to grounding. The eastern entrance to the canal is proposed about a mile above Alloa, where vessels would be raised to the canal level by suitable locks. From Alloa the canal would pass to the north of the links of the Forth, and to the northward about half a mile of the town of Stirling, then along the valley of the Forth to Gartmore, and enter Loch Lomond near the mouth of the Endrick, a distance of 28 miles. Near the Loch Lomond end a deep cutting is necessary. It is proposed to make the canal throughout with a depth of 30 ft., with a width at the bottom the same as the Suez Canal—namely, 72 ft.—and side slopes varying with the nature of the material. The locks would be capable of passing the largest vessels afloat, or about 600 ft. in length, and 80 ft. in width, with smaller locks alongside for smaller vessels, so the canal would accommodate vessels of the Navy.

TUNNEL OR CUTTING?

One of the interesting engineering features of this scheme will be the carrying of the canal through the high ground near the Loch Lomond end. Originally it was proposed to tunnel that ground to the extent of 2½ miles, the tunnel to be not less than 150 ft. in height above the water line. But now the idea of making a tunnel has been abandoned, and an open cutting has been substituted. The distances on the route from the Forth to the Clyde are as follows: From Grangemouth to Alloa, 10½ miles, from Alloa to Loch Lomond, 28 miles; up Loch Lomond to Tarbet, 14 miles; and across the neck of the land from Tarbet to Loch Long 1¾ miles. Loch Long is 15 miles in length to its junction with the Firth of Clyde. The total distance, therefore, from Grangemouth to the Firth of Clyde is 69¼ miles. It would have been desirable to have a canal of sufficient width to allow two of the largest vessels to pass each other at any place on the route, but, as such a work would be too costly, frequent passing places will have to be made at suitable intervals.

As against the cut from Loch Lomond to Loch Long across the Tarbet Isthmus, it has been proposed by others that a route should be taken from a point opposite to where the canal enters the lake, and by a cut of about four miles to the Clyde. This would shorten the total length of the waterway by about fourteen miles, but it would involve an expensive tunnel. A further alternative is to take ships down to the south

end of Loch Lomond, and thence by canal through the Vale of Leven, to the Clyde at Dumbarton. This would be some seven or eight miles shorter than the Tarbet route, but would involve five miles more of canal, and six miles of river navigation, which means restricted speed, and, therefore, no saving of time on the passage. Up and down Loch Lomond and Loch Long steamers could go at full speed, but not so on the canal or river.

The estimated cost of the Tarbet line of the Loch Lomond route is ten millions sterling, and the estimated cost of management and maintenance, £60,000 per annum.

OTHER SUGGESTIONS.

These, then, are the schemes which now divide attention, but there are others which may also be mentioned. For instance, the first idea was to deepen and enlarge the existing Forth and Clyde Canal, and to change it into a tidal canal without locks; but it was found that this could not be done for less than £14,000,000. Nevertheless, this scheme is again being urged on the Government. Then it was proposed that whatever line was chosen, there should be no locks, but that vessels should be raised and lowered at the seaward ends to a level line of water by means of enormous hydraulic lifts. It was calculated, however, that in the case of a warship the total weight to be moved would be eighty thousand tons, or over, and, although engineers do not regard such a feat as impossible, it is so far beyond anything yet attempted, that they shrink from the risk, not to speak of the enormous cost of the machinery.

COMMERCIAL ADVANTAGES OF THE PROPOSED CANAL.

Apart from the naval question, an indication of the saving in distance that would be effected by a ship canal may be given: From the Clyde to ports on the east coast of Scotland, north-east of England, and north-west of Europe, the distance saved would be from 529 miles to 238 miles; from the Forth to ports on the west coast of Scotland, north-west of England, Ireland, America, and the Mediterranean, the distance saved would be from 487 miles to 141 miles; from the Tyne ports to the St. Lawrence River, the distance saved would be 150 miles; from the west of Britain and north-east of Ireland to the middle western ports of the Continent the distance saved would be from 377 miles to 98 miles. It has been computed that, taking an average measurement of the vessels which pass annually through the Pentland Firth, and an average saving by the canal route of 300 miles, the total annual saving by the canal will be equal to 750,000,000 ton-miles.

The total foreign and coasting traffic which would be directly affected by the waterway amounts to twelve or fifteen million tons per annum—a traffic probably sufficient, at a moderate toll, to yield a fair return on the cost of the undertaking. And it is not only time that would be saved to vessels passing from coast to coast (from the west coast to the Continent, and from the Continent and the east coast to the west, and to America), but also the risks of the tempestuous passage by the north, or the overcrowded passage by the south. This means a decrease of tear-and-wear, and a lower rate of insurance—very important commercial considerations.

From an international point of view, this scheme derives further interest in connection with the Baltic Canal, from Kiel on the Baltic to Brunsbuttel on the Elbe. This is some sixty miles in length, is available for the largest merchantmen, and cuts off about one hundred miles in the distance between the Forth and the Baltic. The two canals would present something like a straight line of route for vessels from northern Europe to America—a line in which a further saving might be effected by carrying out the late Duke of Argyll's idea of a ship canal about a mile long across the narrow isthmus in Kintyre, between East and West Loch Tarbert. This may, perhaps, be the waterway of the future between the Baltic and America.

ITS NAVAL IMPORTANCE.

From a national point of view, however, we have mainly to consider the immense advantage the canal would be were we engaged in a naval war. It would be simply invaluable, as it would enable us to despatch warships with rapidity and secrecy from coast to coast, and would, therefore, leave a larger portion of the fleet at freedom to protect our ocean commerce, and to scour the seas. There are three thousand miles of coast on these islands to be protected, and it hardly needs to be emphasised how important it is to have a passage, absolutely at our own command, for strategical and defensive purposes.

Then this waterway would bring the Naval Base on the Forth into direct and unrestricted connection with the great shipyards and engine works on the Clyde. In fact, it would double the base. The importance of the project may be gathered from the closeness with which the German naval authorities are watching it.

ENGINEERING ASPECT.

As a work of engineering, the scheme may be compared with the Manchester Ship Canal. This is 35½ miles long, and has five sets of locks, the principal of which are capable of taking in large ocean steamers. It is 26 ft. deep and 120 ft. wide at bottom. It is carried through some cuttings as deep as 70 ft. It passes under five railways, which are supported on high-level bridges, giving a clear headway of 75 ft. for vessels passing underneath. It necessitated numerous long and heavy embankments, and the construction of numerous swing-bridges for intersecting roads. The area of the locks at Manchester and Salford is sixty-two and a half acres, with nearly six miles of wharfing. Docks had to be built at three different places; and two rivers and a canal had to be crossed and re-crossed several times. It cost, with all the works, etc., about fifteen million sterling, and it involved more engineering difficulties than are possible on either the Direct or the Loch Lomond route for the Forth and Clyde Canal.

PROS AND CONS.

It will be a good deal easier, from a mechanical point of view, to construct a ship canal now by either of the routes described than when the plans were first made. Since then the Manchester and Baltic Canals have been completed, and the Nicaragua and Panama routes have been thoroughly prospected, engineering science has developed, and mechanical appliances have improved. The commercial advantages have certainly not become less through time, nor has the prospective advantage of opening up the heart of Scotland. To the Direct Route Canal it has been objected that it enters the Clyde where there is congestion of traffic, but if there is to be cutting done, that cutting would be better on the Clyde. The country this canal would pass through is of much value from a mineral point of view. Mr. J. Law Crawford, the projector of this route, has said the objection that the canal he proposed entered the Clyde at a very congested part could be got over by following the line of an ancient canal which debouched on the Clyde a little above Bowling. It had been found that this old channel had been filled up with soft material, but with the extraordinary means we now have for excavating and disposing of not only soft material but of rock, the whole of this material could be dredged out of this ancient channel, and a sea-level canal formed on this land, and it is believed this could be done at less cost than it would take to erect twelve enormous locks. The difficulty would be the disposing of this material. Mr. Crawford's solution is that if a system of Telfer railway were so formed that the end of the line could be carried out gradually along the foreshore on the Firth, and the material simply deposited behind a retaining wall, a very valuable asset could be formed out of the reclaimed land on the shore of the Firth. The soft material that would be excavated might also be used for filling up the foreshore on the Clyde.

The cost of the Direct Canal is estimated, as we have said, at about £8,000,000 sterling. The construction of it would be more easy now than when it was projected, and the commercial necessity for it is greater.

The national advantages of a ship canal are very great, and they do not lose by comparison with the French project for the construction of a ship canal from the North Sea to the Mediterranean, primarily for the purpose of bringing the two French fleets into effective junction when required. Of course a blockade at either terminus could close up the proposed French canal as it could also close up the proposed Scotch canal; but then in either case an effective blockade would require employment of two fleets by the enemy, each in a position which would deprive it of information about the other. Against the possible disadvantages of a blockade of the canal in time of naval war, we would have the positive and immeasurable advantage of our fleets being able to pass unperceived from coast to coast to meet an enemy seeking a vulnerable spot; and the potentiality of ready access from both east and west to the largest ship-producing area in the world. It is hardly, of course, to be expected that the Government would formulate a ship canal policy as a State enterprise at the very outset of the new Naval Base, and especially at a time when hot clamour is arising for reduced naval expenditure. They have not even fixed the dimensions and determined the character of the new naval station. It is to be begun this year with a vote of £200,000, but no limit has been stated for its ultimate cost. Room is, however, left for extending the naval scheme by including the ship canal, if the latter is not adopted as a commercial enterprise. How or by whom the canal will be constructed and completed cannot yet be predicted, but it will probably be an accomplished fact within a very few years, especially if certain countries, which shall be nameless here, go on increasing their navies as they are doing.

BUSINESS SYSTEM AND ORGANISATION.

BY

D. N. DUNLOP.

The previous articles on this subject are as follows: Introduction (July, 1902), "A Simple System of Cost-Keeping in Outline" (August, 1902), "The Cost of Production" (November, 1902), "Cost-Keeping" (December, 1902), "The Question of Labour in Factories" (April, 1903), "Stockkeeping and Recording" (August, 1903).—ED.

SECOND SERIES.—III.

THE PERPETUAL INVENTORY.

WE will now outline some of the records which concern the stockroom.

FIG. 3.

Article $\frac{1}{2}$ by $1\frac{1}{2}$ Machine Bolts. Section 1.—Bin 65.

Date.	Order No.	Received.	Reg No.	Disbursed.	Balance	Unit = 100 cost. s.	d.
Sept. 2 ..	Inventory	1,000	—	—	1,000	6	0
Sept. 2 ...	369	1,000	36	500	1,500	6	0
Sept. 3 ..	371	2,000	39	1,000	2,500	6	3
Sept. 6 ...	374	1,000	43	500	3,000	6	3
Sept. 8 ...	—	—	50	2 000	1,000	6	3

From the requisitions for stock the disbursements of material, part or supply, are entered on the proper cards allotted to each bearing the bin or shelf number, and the balance between goods received and disbursed is carried out, together with the cost price per unit day by day, as shown in the illustration. From this set of cards the weekly inventory statement for the general manager can be made on sheet or in a edger, and a quotation sheet drawn out if desired

The Weekly Stockroom Disbursement Report is drawn out thus:—

FIG. 4.

STOCKROOM REPORT.

Stockkeeper, Phillips. *Week ending Sept.* 23, 1903.

Article.	Reg. No.	Order No.	Shop.	Charge. £	s.	d.	Factory expenses. £	s.	d	Credit stockroom. £	s.	d
Machine bolts	29	617	A	1	10	6		—		1	10	6
Carriage do.	30	625	B	0	6	6		—		0	6	6
Steel ..	31	630	A	4	16	5		—		4	16	5
Discs ...	32	630	B	2	0	5		—		2	0	5
Emery wheels	33	—	C		—		1	2	6	1	2	6
Files ...	34	—	A		—		0	5	0	0	5	0
Brooms ...	35	—	-		—		0	2	6	0	2	6

showing the amounts duly credited and charged to the proper departments.

FIG. 5.

$\frac{1}{2}$ in. by $1\frac{1}{2}$ in. C.R. COLD ROLLED.

Requirements. Date.	Reg. No.	Amount.	Factory order.	Purchase Record. Date.	Order No.	Purchased of.	Amount.	Date	Receipts. Purchase No.	Unit. Amount.	Pound. Cost. s.	d.
June 20 ...	10	1,500	62	June 20 ...	619	J. and L....	1,500	July 2 ...	619	800	5	2
June 30 ...	26	2,000	85	July 1 ...	695	Collard ...	2,000	July 5 ...	695	725	5	2
July 10 ...	18	2,000	71	July 10 ...	721	D. and Co.	2,000	July 15 ...	721	2,180	5	3
July 15 ...	29	3,000	96	July 15 ...	752	J. and L....	3,000	July 28 ...	752	5,150	5	3

FIG. 6.

MANUFACTURING EXPENSE SUMMARY.

Week ending September 22nd, 1900.

Stores.	Reg. No	A	B	C	D	E	F	G	H	Credit. Stockroom.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Belting . .	21	0 10 9	—	—	—	—	—	—	—	0 10 9
Emery Wheel	22	—	2 0 6	—	—	—	—	—	—	2 0 6
Files	23	—	0 10 6	—	—	—	—	—	—	0 10 6
Twist drill	24	—	—	0 4 9	—	—	—	—	-	0 4 9
Brooms	25	—	—	—	—	0 2 0	—	—	—	0 2 0
Stationery	26		—		0 10 0	—		-	—	0 10 0
" ..	27	—	—	-	—			0 5 0	—	0 5 0
"	28		—	- -	—		—	—	0 17 0	0 17 0
				Total ...	...	..	... ...	... ..	...	£5 0 6

	£ s. d.
Last week...	4 3 2
To date	114 10 6

The record office having in hand orders for manufacture and the stockroom inventory for cold rolled, for instance, gives notice to the stockkeeper or to the purchasing agent, if there be one, to make out purchase orders, so that it may be ready to meet the demand for impending requisitions on consulting the stock supply record.

As the goods received cards come in to the record office the amount of cold rolled received is duly entered, as shown in fig. 5, as well as the cost per pound. This record, which can only be compiled by one who has access to data concerning past, present and future operations of the various departments of the factory, prevents the danger of a shortage of stock at a critical moment, a calamity dreaded by all managers.

The non-productive stores requisitions, which are charged as manufacturing expense to each department, are collected from the individual cards allotted to each kind of stores, divided in the drawer alphabetically by means of guide cards, and distinguished by tab cards bearing the numbers of the departments, and are compiled to form the weekly manufacturing expense summary (fig. 6).

This record is used to pro-rate the expenses over each finished product or order; the percentage is calculated thus: the entire output of the factory for a certain period, computed from exact cost records, is divided by the total cost of the supplies used during that period, and the percentage (fig. 7) in the illustration cost summary card, 3 per cent., is added to the total cost of production in order to arrive at the cost selling price.

The Flat Cost Record Card (fig. 8) of each part, according to the factory order number, is compiled from the cost of material and labour, and is divided in the drawer by means of tab cards into the different departments through which it passes.

The importance of the stock tracing card is obvious; it forms a perfect check on all producing departments; each operation undergone by the stock in process of completion is entered on the record, as well as the

FIG. 7. Metal Frame 8 by 20.

TOTAL SUMMARY.

Factory Order No 570. Date – August, 1900.

Material and Labour.	Labour	Material	Cost.
	£ s. d.	£ s. d.	
Lumber ..	-	11 3 6	100 rakes
Cast iron ..	—	0 18 5	
Mall iron ..	—	0 15 9	—
Common steel ..	—	1 14 9	—
Spring steel ..	—	0 6 0	.
Tooth steel ..	—	1 11 4	—
Bolts		0 8 3	—
Nits and washers	—	0 3 7	.
Miscellaneous ..	—	1 16 10	—
Wood shop ..	3 7 3		—
Non-productive, 32 per cent. ..	1 1 7		—
Paint shop ..	1 11 4		—
15 per cent. ..	0 4 9		—
Machine shop ..	1 15 10		—
27 per cent. ..	0 9 9		—
Steel shop ..	2 8 10		—
34 per cent. ..	0 16 8	—	—
Assembly room ..	3 0 10		—
30 per cent. ..	0 18 3		—
Foundry	2 9 3	—	—
22 per cent. ..	0 10 11		—
	18 15 3	18 18 10	—
General expense, 40 per cent. ..	7 10 10	—	—
Manufacturing expense, 3 per cent.	—	0 11 4	—
	26 6 1	19 10 2	45 16 3

FIG. 8.

Machine Shop.								Labour and Material.			
Part W 226. Order No. 151.				Part W 226. Order No. 152				Part W 226. Order No. 153			
Date. 1902.	Hours	Labour.	Material.	Date. 1902	Hours	Labour.	Material	Date. 1902	Hours.	Labour.	Material.
Jan.		£ s. d.	£ s. d.	Jan.		£ s. d.	£ s. d.				
18	10	0 9 0	—	18	10	0 10 0	—				
19	10	0 9 0		19	10	0 11 0	—				
20	10	0 9 0	—	20	10	0 9 0	—				
21	10	0 9 0	7 11 5	21	20	1 4 0	12 5 0				
22	10	0 9 0	—	22	10	0 10 0	—				
23	10	0 9 0	—	23	10	0 9 0	—				
Total...	60	2 14 0	7 11 5	Total	70	3 13 0	12 5 0				
Jan.		£ s. d.	£ s. d.					Jan.		£ s. d.	£ s. d.
25	10	0 9 0	—					25	10	0 9 0	10 15 0
26	10	0 9 0	—					26	10	0 9 10	—
27	10	0 10 0						27	10	0 10 0	—
28	10	0 10 0	8 15 0					28	10	0 9 0	7 8 0
29	10	0 12 0	—					29	20	0 18 0	—
30	10	0 12 0	—					30	20	1 4 0	—
Total...	60	3 2 0	8 15 0					Total	80	3 19 10	18 3 0

number of pieces delivered upon one operation to another. From this record the manager knows that each operation has been inspected and duly passed, before proceeding to the next shop. The quality of the work is thus kept up to standard, and all waste due to carelessness or inefficiency is noted and immediately inquired into.

FIG. 9.

STOCK TRACING RECORD.

Box No. 39. Section No. 1. Bin 45.
Date – Oct. 1st, 1900.

Name of stock
Amount ordered
Trucker, Mills.

Order No. 1,714.
Foreman, Gilman.

Operations in shops.	Drawing Nos.	Amount delivered	Time delivered	Date due	Inspector	Amount lost.	Amount [illegible]
A ..							
B ..							
C ...							
D							

The stock tracing record is compiled from the transfer cards (fig. 10) made out by the record office. On issuing the factory order one foreman fills in the date and the receiving foreman writes his signature. On the first transfer card bearing F.O., No. 339, Piece No. W. 16, for instance, the storage record gives the section and bin from which the raw material was issued on the *out* half; and on the last transfer card for that part, like the one illustrated, the stockkeeper fills in the particulars of storage for the finished part, signs the order and forwards it to the record office after recording the receipt of the finished part in his card ledger.

The total cost of an order is recorded on a card (fig. 7) showing the non-productive labour in the factory pro-rated per shop, and the general expenses and manufacturing expense pro-rated on the whole production cost. This forms the selling cost to which the profit is added to give the selling price.

Needless to say, each firm will find out in practice the special records best suited to their own requirements, and many other than those given here will suggest themselves. The reverse of all the cards can be used at discretion either to continue the face record, or for some different statement. For instance, on the back of fig. 3 details of purchase, shipment, and freight costs may with advantage be entered.

FIG. 10.

TRANSFER CARD.

Factory Order No. 339. Date—Sept. 18th, 1902.

From Dept.—Steel works. *To Dept.*—Machine.
No. of Pieces—30. *Piece No.*—W 16.
Machine used on.—50 Bush. Wagon. *Name*—Side Brace.
Remarks.

Thomson,
Foreman

STORAGE RECORD.

IN.	OUT.
Section—21.	
Bin	
Rack—10.	
Shelf—	
Phillips,	Stockkeeper.

THE ROUTINE OF THE SYSTEM.

When notified that material or stock is required, the purchasing department makes out a purchase order, of which a copy is sent to the stockkeeper and one to the record office. As the goods arrive, goods received cards (fig. 11) are made out by the receiving clerk and forwarded to the stockkeeper as a record of

FIG. 11.

GOODS RECEIVED CARD

From Jones and Lancaster, Sheffield. Date—Jan. 18th, 1903
Purchasing Order No. 670.

Received by Mitchell. Opened by — Checked by Mitchell. Entered by — Dray Messenger G.N. Railway.

Quantity	Article.	Price s.	d.	Storage. Section	Bin	Shelf
10,000	$\frac{1}{2} \times 2\frac{1}{2}$ Com. Steel per lb. ..	5	10	1	35	
5,000	$\frac{3}{8} \times 1\frac{1}{2}$,, ,, ...	5	10	1	37	
2,000	$\frac{1}{4} \times 1\frac{1}{4}$,, ,, ..	5	10	1	38	
10,000	$1\frac{1}{4}$ Round cold rolled cut 12 ft.	7	5	2	60	
3,000	1 ,, ,, 7 ft	7	5	2	72	
	Add freight and lading ...					

Remarks.—G.N.R. Car 1875. Cold rolled slightly rusted.
Johnson, Receiving Clerk.
Purchasing Agent punch.

the price paid for goods and the freight and lading charges; the stockkeeper fills in the storage items. The factory or record office should draw out the cards and issue them to the receiving clerk in expectation of their arrival, leaving only signatures, dates and freight charges to be inserted. A duplicate goods received slip is forwarded to the purchasing agent who enters the items in his ledger, checks the invoice and O.K.s. the card, before sending it to the record office. If there be no record office the stockkeeper or his clerk makes out the perpetual inventory card (fig. 3) day by day as already explained, and files it in his inventory cabinet; this forms the stockroom receipt for the goods which are at once charged to that department and credited as disbursed.

As the various shops receive a copy of a production or factory order, each foreman, noting the particulars of material prescribed therein, makes out a requisition for stock (fig. 12) for each kind of stock, or signs and dates those made out in the record office; the far better plan, for the less clerical work given to foremen and superintendents the more attention they can give to their specific work. Allowing due time for delivery from the stockroom, the foreman sends the requisition cards by pneumatic tube to the stockkeeper, who attends to the weighing or counting out, supervises the packing in boxes, placing each requisition

FIG. 12.

REQUISITION FOR STOCK. No. 39.

Foreman, Williams. Date—Jan. 10th, 1901.
Factory Order 1,714. Shop A.

Quantity	Description.	Weight or feet	Price.	Deduct from Bin.	Sect.
2	Bars $\frac{3}{4}$ in. by 1 in. com. steel for side brace on 50 bushel wagons, No. 16 ...	30	5·5	2	1

Delivered. Date—Jan. 16, 1901
Trucker, Stanton. Received punch.

card in the tin pocket of the box for identification. The truckers on delivering the stock wait for the requisition card to be punched by the foreman as a receipt for the goods, and return the cards to the stockroom, when they proceed to the record office after having been entered on the stockkeeper's card ledger.

From the cost column, the exact copy of material is ascertained and charged to the factory at the exact purchase cost, and not at the current cost.

Day by day the stockkeeper sends in a stockroom report to the office from which the weekly record is compiled (fig. 4). Once more, finally, the stockkeeper receives a requisition (fig. 13), this time from the assembly room for ten lots of finished parts, which leave the department as ten fifty-bushel standard wagons, and are sent to the warehouse or direct to the

FIG. 13.

ASSEMBLY ROOM STOCK CARD.

Clarke, Foreman. Date—Oct. 19th, 1902.
Stock below required for Factory Order 339.
10—50 Bush. Standard wagons.

Quantity.	Piece No.	Description.	Entered Card.	Storage ord. of Sec.	Bin.	Rack	Shelf.
60	W 10	Side boards...	Baker	18		21	
40	,, 11	Bottoms ...	B.	18		22	
30	,, 12	Front ends ...	B.	18		23	
10	,, 15	Toil gates ...	B.	18		26	
50	,, 16	Side braces ...	B.	21		16	
20	,, 17	End braces ...	B.	21		18	

shipping department if wanted at once to fill an order. The stockkeeper enters the disbursement on his card ledger; registers it on the bin or rack dial-indicator, and forwards the card to the office.

BRITISH AND FOREIGN TRADE:

A REMARKABLE BLUE-BOOK.

A BLUE-BOOK on matters connected with British and foreign trade and industrial conditions, which makes an extremely opportune appearance at the present time, has been issued by the Board of Trade. It is a remarkable volume, consisting of 500 pages of letterpress, statistical tables and charts, packed with information, and collated under the direction of Sir Alfred Bateman, who contributes a prefatory note, and Mr. Llewellyn Smith, who is largely responsible for the editing. The Blue-Book weighs about 3½ lb.

SCOPE OF THE VOLUME.

The contents of the volume are so diverse, and its utility so far-reaching that it should be obtained by all who are concerned in quoting facts on this important subject. The matter is arranged under 31 headings, which include varied statistics of exports and imports of manufactures, the supply of foodstuffs and raw materials, wheat prices, freight rates, the practice of foreign countries with regard to preferential trade, former preferential duties in the United Kingdom, the tariff treatment of British products by foreign countries, the comparative incidence of foreign and colonial import tariffs on the export trade of the United Kingdom, the consumption of food and cost of living of the working classes at home and in other countries, the course of wages at home and abroad, the export policy of Trusts, occupational distribution of industrial population, statistics relating to special trade groups (tinplate, textiles, iron and steel, shipbuilding), and miscellaneous tables relating to population, emigration, foreign trade, profits and capital, money market, banking and currency, pauperism, production of coal and iron abroad, and other subjects.

The value of the tables is in several instances enhanced by marginal statements as to important events—political, fiscal, and general—bearing on economic conditions. The volume reaches us as we are on the point of going to press, and we have not time to give it more than a cursory examination. We hope on a future occasion, however, to deal more in detail with some of the carefully compiled tables, a specimen of which, dealing with our exports of coal and machinery in the last fifty years, is appended.

THE EXPORT POLICY OF FOREIGN TRUSTS.

Interesting reading is afforded by the pages devoted to the export policy of foreign Trusts.

"Although many of the leading industries of the United States have for many years past been controlled by powerful combinations, the great development of the Trust system in that country has to a certain extent coincided with the recent remarkable spurt of prosperity in America. The available evidence goes to show that for some time past the United States has for the most part been able to absorb, and has, in fact, kept at home a great proportion of its total output, and that during this period of exceptionally good trade in the American home market, the inducement on the part of the Trust organisations of the United States to 'dump' surplus goods at low prices in foreign markets may fairly be considered to have been slight, as compared with what might be manifested in a time of industrial depression in the States."

A number of statements are quoted from Vol. XIII. of the report of the U.S.A. Industrial Commission, which contains an account of the results obtained in a special investigation into the truth or falsehood 'of the frequent assertion that exporters of American-made goods often sell them in foreign countries at lower prices than are obtained for similar goods at home.'

AMERICAN IRON AND STEEL.

Further details with respect to the nature and extent of the imports of iron and steel from the United States into the United Kingdom, compiled from trade reports published in the course of the last few years are to be found in an appendix.

The details given in this appendix show that, while the manufactures of this country were free from the competition of American iron and steel in 1899, the first months of 1900, saw the United States begin an invasion of the British market, which was carried on with remarkable energy until the early part of the following year, after which this campaign came to an end.

The American imports included a great variety of materials, such as pig-iron, iron bars, raw steel, bedstead angles, and ship-plates. These articles were thrown upon our market at prices which were in many cases much below those quoted by our own makers; and

Value of the Exports of Coal, Machinery, and of All Other Articles of British Produce (except Ships) to All Destinations in each Year 1850–1902.

Year.	Coal (including Coke, Cinders, and Patent Fuel).	Machinery and Mill Work.	All Other Articles (except Ships).	Total Value of Exports (exclusive of Ships)
	Thousand £.	Thousand £.	Thousand £.	Thousand £.
1850	1,284	1,042	69,042	71,368
1851	1,302	1,169	71,978	74,449
1852	1,372	1,252	75,453	78,077
1853	1,605	1,985	95,344	98,934
1854	2,127	1,931	93,127	97,185
1855	2,446	2,243	90,999	95,688
1856	2,827	2,716	110,284	115,827
1857	3,210	3,884	114,972	122,066
1858	3,046	3,599	109,964	116,609
1859	3,270	3,732	123,410	130,412
1860	3,372	3,838	128,681	135,891
1861	3,605	4,214	117,284	125,103
1862	3,751	4,092	116,149	123,992
1863	3,714	4,368	138,520	146,602
1864	4,166	4,848	151,435	160,449
1865	4,427	5,223	156,186	165,836
1866	5,103	4,759	179,056	188,918
1867	5,392	4,969	170,601	180,962
1868	5,353	4,729	169,596	179,678
1869	5,166	5,119	179,669	189,954
1870	5,638	5,293	188,656	199,587
1871	6,246	5,966	210,854	223,066
1872	10,442	8,201	237,614	256,257
1873	13,189	10,020	231,956	255,165
1874	11,984	9,791	217,783	239,558
1875	9,658	9,059	204,749	223,466
1876	8,905	7,210	184,524	200,639
1877	7,844	6,723	184,326	198,893
1878	7,330	7,498	178,021	192,849
1879	7,207	7,279	177,046	191,532
1880	8,373	9,264	205,423	223,060
1881	8,786	9,960	215,277	234,023
1882	9,564	11,446	220,457	241,467
1883	10,646	13,022	216,124	239,792
1884	10,851	12,717	209,457	233,025
1885	10,633	10,715	191,767	213,115
1886	9,837	9,702	193,186	212,725
1887	10,170	10,623	201,121	221,914
1888	11,345	12,494	210,596	234,535
1889	14,782	14,672	219,481	248,935
1890	19,020	16,411	228,100	263,531
1891	18,895	15,070	213,270	247,235
1892	16,811	13,069	197,336	227,216
1893	14,376	13,200	190,684	218,260
1894	17,372	13,435	185,199	216,006
1895	15,434	14,236	196,458	226,128
1896	15,156	16,059	208,931	240,146
1897	16,655	15,181	202,384	234,220
1898	18,136	17,306	197,917	233,359
1899	23,094	18,372	213,830	255,296
1900	38,620	19,620	224,364	282,604
1901	30,335	17,812	222,726	270,873
1902	27,581	18,755	231,216	277,552

there can be little doubt that these materials were sent over here rather with the object of keeping the United States works employed than of earning any substantial profits for their owners.

With regard to the effect produced upon British Trade by the export policy of the American manufacturers of iron and steel, much the same observations will apply as are made elsewhere in relation to the German imports of the materials in question. The American imports were by no means of equal advantage to all classes of British trade. Blast-furnace owners, the producers of manufactured iron, and the makers of raw steel could not be expected to welcome the American invasion, which certainly restricted the demand for our pig-iron, and exercised a not unimportant influence upon the price of manufactured iron, and of steel, both raw and manufactured. But the large class of industries which made use of the American materials for working up—our tin-plate workers, for example, our bedstead manufacturers, and our shipbuilders—probably took a less favourable view.

To arrive at any really definite conclusion in relation to the export policy of the American Trusts upon evidence such as is alone available in the present instance, is by no means easy. On the whole, the general impression, which an attentive perusal of the details leaves upon the mind of the investigator, is that, while the manufacturers of the United States, even with trade as good as it has recently been in their own country, send away to foreign destinations a not inconsiderable proportion of the commodities which they produce, these goods have in numerous instances been sold abroad at lower prices than in the United States. That their foreign prices have been, to a more or less material extent, lower than their domestic prices, the Trusts in some cases allow to be the fact; but not infrequently appear reluctant to admit; nor, under existing circumstances, can they reasonably be expected to volunteer very exact information on this point. But a comparison of the recent trend of prices in the United States and in other countries, especially in the United Kingdom, suggests a doubt whether part at least of this export trade of the Trusts could have been carried except by granting the foreign purchasers prices lower than those ruling in the United States. It is to be remembered, however, that the last few years have been years of active trade in the United States, when the inducement to reduce export prices in order to maintain output is less than would be the case in times of depression."

PAGE'S MAGAZINE

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OUR MONTHLY SUMMARY.

LONDON, September 20th, 1903.

The Iron and Steel Institute.

The most important event connected with the technical societies during the month was the annual meeting of the Iron and Steel Institute, which, for the second time in its history, met at Barrow, termed by Mr. Andrew Carnegie the cradle of the industry. The visitors received a hearty welcome from the people of Barrow, and, luckily, the weather, though threatening, did not interfere to any appreciable extent with the outdoor functions. As is usual at these meetings, there were more papers than could be adequately dealt with, and some of the points raised demanded days rather than hours for discussion. This will be noticed on reference to our summary of papers in another part of the MAGAZINE. In this respect, these annual gatherings must have a somewhat disappointing aspect, especially to the authors of the papers. That the meeting passed without a hitch of any kind reflects considerable credit upon Mr. Bennett H. Brough, the Secretary, and the local committee. Next year the Institute pays its second visit to America.

Do We Want Eight New Universities?

During the month the British Association has held its deliberations at Southport, and we find ourselves face to face with a new aspect of the education question.

This is an age of astounding proposals. Following Lord Rosebery's scheme for an English Charlottenburg, which is fortunately backed by philanthropy, comes a suggestion made by Sir Norman Lockyer, in his Presidential Address to the Association, that we require eight new universities, for which the British taxpayer would presumably have to find the cash. As the trade now follows the brains instead of the flag, Sir Norman thinks we should turn universities out as we do battleships, and the preliminary instalment, it is to be noted, would cost £24,000,000. We are invited to contemplate an analogy that certainly appeals to the imagination, but we fear that it is somewhat in the clouds. There has already been such a bewildering mass of divergent opinion upon this vital question of scientific training that anything savouring of exaggeration can only tend to confuse the issue. On our part, we are inclined to think that the duplication of universities is less likely to be helpful than the thorough co-operation, and in some cases reorganisation, of existing institutions, combined, possibly, with a conference of leading manufacturers, at which some kind of an understanding might be arrived at for the further encouragement of students. We are assured in some quarters that the country does not lack facilities but is in need of advanced students, able to take advantage of the opportunities offered them. It is by one writer urged that the London schools at the present time are full of highly capable teachers "pining for the opportunity to display their powers." It is also alleged that there is a lack of appreciation by the pioneers of industry and the industrial community generally, of the value of scientific education.

A South African View.

The non-appreciation of technical education by manufacturers is perhaps more apparent than real.

Much of the theoretical training, at any rate, must be regarded as capital invested. If young men expect to reap an immediate reward for their efforts before gaining the practical business experience which is no less necessary, they are fore-doomed to disappointment. But in the long run the theoretical training will pay. It is interesting to see the attitude which is taken up on this question in South Africa. Mr. Catlin, in the course of his Presidential Address to the Mechanical Engineers' Association of the Witwatersrand, remarked that "in this utilitarian age the demand for technical education is constantly increasing. Not many years ago experience was at a premium, the higher technical knowledge was deemed too theoretical for the uses of every-day life, and was largely confined to college professors and scientific enthusiasts, who were regarded as more or less eccentric but harmless. But since that time the world has awakened to a realisation of fact that a technical education is not only founded on experience, but that that experience is not bounded by the narrow horizon of one individual, being the cumulative result of the experience of all investigators since history began, and that it brings with it a broadening effect. For not only does it point the way to great achievements, but it dignifies all honest effort to that end, and breaks down many of the absurd notions that were barriers to good honest work. There is not now so much admiration for the young man who is proud of the fact that he does not know how to black his own boots should occasion require it. Not long since I met one of the heads of a great manufacturing company on his way to 'look over,' as he expressed it, the graduating class of a celebrated technical institution with a view to securing the services of some of them. Young men are wanted who have the advantages of the ground work of a technical education. The largest works are full of them, and they find it pays to train them in the practical application of the knowledge they have acquired. It seems quite evident that there is a growing demand for technical men in all the great industries of the world."

The Industrial Evolution of the Rhineland.

In the course of a very notable series of articles commenced at the beginning of September, the *Times* placed before its readers a systematic picture of German activities which cannot fail to be of great assistance to those who are watching commercial developments at home and abroad. The most formidable districts in competition with England, *i.e.* Rhineland provinces of Prussia and the Kingdom of Saxony, were mainly described. Of urban life in Germany the commissioner notes that orderliness is its chief quality, overcrowding its greatest defect. He remarks that the modern industrial evolution of the Rhineland, particularly in iron and steel manufactures, which have attained such a remarkable development, may be attributed in the first instance to the coal mines of the province and of Westphalia, which adjoins it on the eastern side, and in the second to the great waterway of the Rhine and an excellent system of railroads. The extensive Rhine-Westphalian coal basin stretches eastward from the river, where the Ruhr joins it below Düsseldorf, for some thirty miles into Westphalia. Essen and its neighbours in the Ruhr valley stand upon it, but the bulk of the mining district lies over the border in Westphalia. It is a hilly region, almost given up to coal and iron. One group of smoky furnaces and tall chimneys follows another—Bochum, Hagen, Herdecke, Hörde, Dortmund, and others—interspersed with coalpits and tidy mining villages. Yet it cannot be called a "black country," and in no wise resembles the desolation of South Staffordshire, for amid all the pits and furnaces the cheerful Westphalian farms surrounded by trees and well-cultivated fields, smile prosperously from the hillside.

Coal to Newcastle and Electrical Machinery to ——

There is a remarkable passage in the first article, which does not make pleasant reading from the point of view of the home manufacturer. No apology will be needed for quoting it *in extenso* :—

"Among the more notable establishments are those of the Düsseldorf-Ratinger Tube Boiler Works, where the Dürr boilers are made; of Ernst Schiess, whose heavy machine tools are famous all over the world; and Messrs. Haniel and Lueg, who employ about 2,000 men and make all kinds of engines and machinery. These firms, I regret to say, send a great deal more of their manufactures to England, and often to the very towns where the same things are made, than is at all flattering to us. I have seen heavy machine tools going to Glasgow and Barrow, hydraulic presses and steel ingots to Sheffield, crank-shafts for electrical machinery to Manchester, shaft linings and a shaft borer to Kent, pumps to Middlesbrough, forgings for machinery to the Tyne, and many other things. And do not let anyone suppose that these things are 'cheap and nasty.' That phrase is absolutely out of date in regard to German products. The work is first rate, as every English manufacturer knows who visited the brilliantly successful Düsseldorf Exhibition in 1902. The verdict of one highly competent authority, who has visited every industrial exhibition for the last fifteen years, and knows the United States as well as England and other parts of Europe, will suffice. 'It was,' he said, 'the finest show of machinery and tools ever seen.' Nor is the export trade all 'dumping' of surplus products. Haniel and Lueg are executing more orders for England than for Germany, although they only entered the English market two or three years ago. The day before I visited the works they had received £9,000 worth of orders from England in one morning. Besides the firms mentioned, there are many other well-appointed steel and engineering establishments, some large glass works and a number of miscellaneous factories."

Electric Lighting Plant and British Trade.

Some gratifying remarks on the electric plant for the public supply of Sydney were made by Mr. S. R. W. Gardam, in the course of his Presidential Address to the members of the Electrical Association of New South Wales. After alluding to the fact that Messrs. Preece and Cardew had drawn up a scheme admirably suited to the requirements of the city, he continued :—

"Though the misguided and unenlightened being thinks he is showing the broadness of his views, and that he is no jingo, by buying foreign material, and in fact, gives advantage to the foreign article over the British made goods, it is highly gratifying to note that the City Council, by their choice of plant, etc., will not only have obtained a plant at a lower cost, but, as time will prove, one more efficient and lasting than they would have had had they bought it outside this Empire. Can anyone in this room give any reason why, other things being equal, we should assist foreign labour and particularly those countries which by their prohibitive tariffs absolutely prevent the competition and importation into their own countries of British made goods? Is it any reason that because the wool and produce of this country

finds its way into European markets, because they cannot buy a sufficient quantity elsewhere at a lower figure, that we should reciprocate by purchasing machinery from them which we can ourselves turn out as well, if not better, than they.

"I have been approving of the tramways as a system, but cannot refrain from saying that that huge mass of foreign material running at Ultimo, and along our streets, is indeed a reflection on our Government and its advisers. It appals one to know that in a British country, British firms were not even asked to tender for the last large expenditure on the generating plant, and for this State's sake, I trust the engines, which are similar to those which alongside the Musgrave engines at Glasgow, cut so poor a figure, will give better results here.

"By the good sense of the Council an indication is given that the scare and oft-repeated mis-statement implying British decadence is being corrected. It may be admitted that owing to the necessarily conservative laws of the older countries, we have been left a little behind in some small matters, but I have yet to learn that England cannot turn out engines, above all things, superior to those built anywhere else."

Problems for the Colliery Manager.

At the annual meeting of the National Association of Colliery Managers, at Leeds, Mr. Walter Hargreaves, in the course of his Presidential Address, touched upon a number of questions of importance to the mining engineer, though certain points were not fully dealt with owing to the fact that they are being considered by the Royal Commission on Coal Supplies, and the Departmental Committee on Electricity in Mines. On the question of cheap transit, he remarked that, whilst all that concentration of capital and management, unstinted expenditure of energy and mechanical skill could do, had been done for railways, our canals had, with one or two exceptions, remained as they were when first made. He would personally like to hear more about water transit, and would look forward with interest to the evidence regarding it which would be put before the Royal Commission. He hoped to see a revival of a question which he felt sure was of greater national importance than that of high-capacity wagons. Referring to the work of the Departmental Committee on Electricity in Mines, he remarked that there were already in this country many mines with large and up-to-date electrical plants, and several others were contemplating the use of this power for every purpose, both surface and underground, to which power could be applied; and upon the report of the Committee would depend, to a great extent, the question as to whether the use of electricity was to be advanced or retarded. In the evidence published one witness proved, as a result of experiment, that an electric motor might be so enclosed as to run in an explosive atmosphere without danger of igniting gas; other witnesses considered electricity safer than any other power ever used in fiery mines; but all the witnesses seemed to agree that the principal thing to be looked to in rendering the use of electricity safe, was the quality of the installation, and that with good work and the use of ordinary precautions, electricity was a perfectly safe and reliable power to use in coal mines. The labour question was probably the most troublesome that the colliery manager had to deal with at the present time, and would continue to be so until some means was found of regulating wages by arbitration, whether made compulsory by Act of Parliament or arranged voluntarily. So far as the legal power of trade unions went, the present year had seen the turning point, and they knew now that there was a limit at which every trades union must stop in its interference between employer and employed.

The Conquest of the Air.

Mr. Santos Dumont is not by any means to have the conquest of the air left solely in his hands. An event which created great excitement in the metropolis last month was the attempt made by Mr. Stanley Spencer to sail his airship from the Crystal Palace, round the dome of St. Paul's Cathedral, and back again to Sydenham. The Cathedral was reached in about twenty minutes, but after completing a semi-circle, the aeronaut found that the wind was too strong to admit of his returning to the Crystal Palace, and he accordingly headed for the North, descending at New Barnet, and thus completing a flight of about seventeen miles. The new airship consists of a cigar-shaped gas-vessel supporting a triangular framework, on which is fitted the motor. The gas-vessel, 93 ft. long and 24 ft. maximum diameter, is fitted with a "ripping valve," by means of which the gas may be speedily released, and there are also inlet tubes for inflating the vessel with hydrogen and for pumping in air, as well as an automatic valve, which relieves any undue pressure before the bursting point of the fabric is reached. Running horizontally round the gas-vessel and securely fixed to it is a sailcloth band, which supports the pendant weight. This band also forms a safeguard by assuring that the gas-vessel shall take the form of a parachute. The framework, which hangs 12 ft. below the balloon, is of bamboo construction, stayed with steel wires, and measures 50 ft. long. It carries in front the "tractor," which is 12 ft. in diameter, on a steel shaft supported by bearings and connected through gear-wheels and a clutch with a motor. The petrol motor is situated in the forward part of the framework, and is of 24 h.p. The motor used by Mr. Spencer in his other airship was only 4 h.p. The new motor develops its power when running at a speed of 1,050 revolutions per minute, and this speed is reduced by the gearing to 300 revolutions per minute, the rate at which the "tractor" revolves. In the rear part of the framework is the car, from which the aeronaut has control of the motor and the clutch by means of levers actuating wires. He also has ropes from the rudder, which is suspended at the rear of the framework, and by which he can direct the course of the airship to the right or left as desired. He can also vary the altitude in two manners: first, by means of a balance-rope, which enables him to point the airship upwards or downwards; and secondly, by means of a hand-blower for pumping the air into the gas-container and thus causing it to descend by the increase of its specific gravity.

Airships are also attracting considerable attention in America, the latest claimant for honours being Dr. August Greth, a physician of the City of San Francisco. The propeller power is furnished by the motor, which runs two eight-blade propellers, which have a speed of 1,800 revolutions a minute, and are controlled by a steering wheel in the car. They can be deflected at any angle without stopping or reversing the engine. They not only propel the boat, but also steer it according to the angle at which they are. Mr. Santos Dumont has but one propeller, fixed and rigid, and he steers with a canvas rudder, which, Dr. Greth says, does not take action readily until the ship is under good headway. Mr. Santos Dumont also has to carry and use a shifting weight to incline his machine.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

IN the May number of this magazine, I referred to the fact that the new college at Osborne, intended for the naval cadets to be trained under the new scheme, would be opened in the autumn. As a matter of fact, the youngsters joined on Monday, September 14th, and the course of instruction began on the following day. Prior to the opening of the college for educational work, a party of gentlemen interested in naval matters was invited by the naval authorities to inspect the buildings, and an account of the excursion will be found elsewhere in this number. With the details of that interesting and instructive visit, therefore, I do not propose to deal. But as this may be looked upon as the raising of the curtain upon the new scheme in execution, it seems fitting that I should take as my topic for the introduction to these notes on this occasion the subject of the new training.

It is well to remember that not only in point of age but in the matter of selection, an entirely new plan has been carried out in regard to these cadets who have just gone to the college. The age has been lowered by something more than two years; indeed, some of the youngsters who presented themselves among the nearly three hundred candidates to be examined were very little over eleven. An official list has been published of the schools from which the eighty selected candidates were drawn, and this shows the very wide field that has been opened up. The plan of selection followed was to bring each candidate before a committee, which consisted of two naval officers, one a Lord of the Admiralty, and the other one who had had considerable experience in the training of cadets, a schoolmaster with at least twelve years of experience at Harrow, and a civilian official at the Admiralty who has for long been connected with the previous arrangements for selecting applicants for nominations. Each boy also brought with him a statement from the family medical adviser of his previous history, and also a report from his schoolmaster, framed on specific questions supplied to him. These reports formed the basis for selection, and in addition, each youngster was given a couple of popular subjects on which to write a short essay to test his handwriting, spelling, and powers of expressing himself. As an example of the subjects chosen, and the result, it may be mentioned that one boy who was three months short of twelve years of age, was asked to explain what he thought were the chief duties of a naval officer. He wrote: "First, to serve his King and country; secondly, to be the last person to leave his ship if she was wrecked; thirdly, to obey his superior officers." It would be difficult for any grown man to put the matter more tersely.

The second test consisted of a series of simple questions on all kinds of subjects, chosen so that they should not be beyond the capacity of a boy of twelve. Many of these questions and the answers they elicited have been published; they go to show that, as a rule, in fact, with very few exceptions, in deed, the boys were quickly at their ease, and answered the questions put to them frankly and without any nervousness. The report of the examiners and of the Director of Naval Education who was present at many of the meetings of the Committee, is said to have been unanimous as to the fairness of the method of selection, and its generally satisfactory nature.

The boys thus chosen have now gone to Osborne, and have entered upon a course of school training, the principles of which I explained in my notes in the June issue. The education of a naval officer has been compared to the making of naval rope, in which there are three strands laid together, and a small thread of coloured stuff running through the strands indicating that it is Government property. In times now gone by the three strands represented the three subjects: Seamanship, Navigation, and Gunnery, while the little coloured thread stood for that sea aptitude which is imparted by an early familiarity with the actual conditions of life afloat. The strands of rope may be separated, or the rope severed, but the little coloured thread cannot be entirely picked out; once woven with the rope, it remains for ever. The result of the new training is to substitute a new strand for an old one. The scientific training of an engineer takes the place of that scientific training which was connected with the sailor's art. Seamanship remains, in so far as it belongs to the sea aptitude, and in so far as it is connected with practical navigation, but for the purpose of illustration, it may be said that the three strands are now Engineering, Navigation, and Gunnery, instead of what they were when masts and sails and all that

pertained to them filled such an essential function in the making of a seaman.

How these strands are to be woven together the course of instruction at Osborne shows. The novel feature in the school work is, of course, the engineering studies, which it is arranged shall be directly connected with the teaching of mathematics, physics, and the applied sciences, so that the minds of the cadets shall be prepared by one course for another. Practically, this means that there will be an alternation of theoretical work, with the studies carried out in the machinery shops and laboratories. The change and variety of occupation should stimulate and encourage the faculties of the cadets, and great interest attaches to this portion of the scheme. Apparently, the classes will not consist of more than fourteen or fifteen boys, and when it comes to practical instruction not more than a third of this number. The lessons, too, are to be limited in length to about three-quarters of an hour for each of the theoretical subjects. Fifteen lessons during the week will be devoted to practical engineering, which includes the handling of machinery in the instructional steamboats, the use of tools in the workshops, and lectures on the parts of the engines and the elementary theory of steam machinery. The other subjects in which instruction will be given concurrently will receive attention according to their place in the following list: mathematics coming first, and French next, then history, mechanics, and practical physics, the remainder of the time being devoted to geography, English grammar and composition, English literature, and a study of the Bible. It will be noticed that neither Latin nor Greek are included in the curriculum. With regard to seamanship, navigation, and drill, subjects which are not mentioned above, these of course, find a place in the scheme, at least one hour a day will be devoted to them, while in addition, opportunities for acquiring a knowledge and experience in this connection will be given by trips of a week's duration in the training cruiser attached to the College. And during these cruises the ordinary studies are not to be interrupted.

Naturally, the scheme here outlined is and must be, more or less in the nature of an experiment at first. As time goes on modifications may become necessary, but, in any case, the result will be looked forward to by all interested in education and the training of youth, with the greatest interest. For the present it does not appear to be decided whether the boys shall go on from Osborne to Dartmouth; indeed, two years must pass before the matter requires to be settled. And then the course of studies at the Britannia College will also need some alteration and expansion if, indeed, this does not happen before.

GREAT BRITAIN.

The date officially fixed for the passing into the Medway Fleet Reserve of the *Duncan* is September 30th, so that by the time these lines appear, the whole of her class should be out of the contractors' hands. They were all laid down in 1899, with the exception of the *Albemarle*, of which the first keel plate was laid in January, 1900, at Chatham. This ship, however, took the water on the same day as the *Montagu* which had been two months longer on the stocks at Devonport. The *Duncan* is to be commissioned on October 8th, and will go to the Mediterranean station.

The launch of the *Dominion* at Barrow, on August 25th, makes three, but not all, of the vessels of the *King Edward VII.* class in the water. The *New Zealand* and *Hindustan* of the 1902-03 programme, are still on the stocks at Portsmouth and Clydebank respectively, and although work on them is being pushed forward vigorously, they cannot be expected to take the water for two months or more. The *Dominion* is similar in design to her sister ships, which I have already described in these notes, but some interesting details concerning her armament have been published which should be added to my previous remarks. The 12-in. guns, of which there are four in each ship, are capable of developing an aggregate muzzle energy of 45,000 ft.-tons, with a projectile of 850 lb., which, under suitable conditions, would still be capable even at five miles range of penetrating 6-in. armour. The 9·2-in. guns, of which there are again four to each ship, are almost equally effective, and there are in addition, ten 6-in. quick-firers, and thirty-two smaller pieces. In all the *Dominion* has a capacity for firing one hundred and four shots per minute from her principal guns, totalling in weight 20,880 lb., and exerting a muzzle energy equal to 1,289,472 ft.-tons. From each broadside in that time eight projectiles of 850 lb., eight of 380 lb., and forty of 100 lb. can be fired; or ahead she could fire four projectiles of 850 lb., eight of 380 lb., and sixteen of 100 lb. From her smaller guns in a minute two hundred and eighty 12-lb. projectiles, three hundred 3-lb., and four thousand eight hundred rifle bullets can be discharged. The exact design of the three battleships of this year's programme has not yet been made public, but it is believed they will be similar to the *King Edward* class, but will carry eight instead of four 9·2-in. guns.

The new armoured cruiser *Cumberland*, built by the London and Glasgow Company, has finished her official trials in the Firth of Clyde with complete success. This change in the *venue* of the trials is due, of course, to the decision of the Admiralty to have all vessels which are built in private establishments completed at the contractor's works. The boilers of the *Cumberland* are of the Belleville type, thirty one in number, and throughout the trials they worked without trouble of any sort.*

Particulars of the *Lancaster's* trials I must reserve for the next issue. Her gun trials were reported to have been carried out with entirely satisfactory results, but it was not stated whether the gun sights which were so defective in the *Donegal* have been improved upon for the *Lancaster*.

There were no launches of small craft during

* An account of these trials is given by our Clyde Correspondent in "Shipbuilding News."—Ed.

September, and although trials of several torpedo vessels have been carried out, details are lacking.

The results of the 30-hours' trial at one-fifth (2,500) i.h.p. of the *Challenger*, cruiser, which was built at Chatham, and engined by the Wallsend Slipway and Engineering Company, were as under :—Steam pressure in boilers, 241 lb. ; revolutions per minute, 105·6 ; i.h.p., 2,636 ; speed of ship, 12·8 knots. The coal consumption was 1·74 lb. per i.h.p. per hour. The vessel also carried out a progressive trial off Rame Head, when the mean speed for four hours was 13·15 knots.

FRANCE.

The French Naval Budget for this year, on the figures of which I commented in July, has come in for much criticism in the French Press, particularly the fact that only one armoured cruiser is proposed to be laid down, the remainder of the programme consisting entirely of small craft. Seventy vessels will be laid down during 1904, according to the Budget, and fifty of these will be torpedo-boats, and sixteen of them submarines. The one armoured cruiser will be laid down at Brest, and will be of the *Ernest Renan* type, 13,644 tons in displacement, 523 ft. long, 71 ft. beam, 36,000 i.h.p., and 23 knots speed. Two torpedo destroyers of the *Stylet* type will be laid down at Rochefort, and one at Saigon. In 1904, also, it is anticipated that forty-nine new vessels will be brought into service, although not one of these is a battleship. Three of them are armoured cruisers, the *Dupetit-Thouars*, the *Condé*, and the *Léon Gambetta*, but it is most doubtful whether the last-named will be fit to be commissioned before 1905. Seven torpedo-boat destroyers, and twenty torpedo boats will also be completed, and no fewer than nineteen submarines are to be put in commission.

The *Suffren* gunnery experiments have caused a good deal of comment, and although the published accounts differ largely in many details, they are agreed in saying that the turret was workable after the shell from the *Masséna* had struck it. The target was a sheet of steel 25 centimetres in thickness, covered with canvas, and erected on the side of the fore turret. The fact that an additional plate was affixed robs the experiment of much of its reality. The trial has been described as artificial, and such it undoubtedly was. In all, four shots were fired, of which two at least struck the target fairly. The projectiles (which may have been only an armour-piercing shot) broke in both cases ; on the second occasion, however, a heavier charge having been used, the pieces flew about more, and some rebounded unpleasantly near the *Masséna*. As to whether the guns could be worked as usual, we are never likely to learn. The only official remarks on the subject are contained in a letter from M. Pelletan to the St. Chamond works, closing a contract for some turret plates. He waited, he said, until the result of the *Suffren* experiments were known, and this is taken to mean that the plates of that vessel's turret have successfully withstood the test.

A new French armoured cruiser, the *Jules Ferry*, has been launched at Cherbourg. The *Jules Ferry* belongs to the *Léon Gambetta* class, and was laid down in 1901. She is 482 ft. in length, with 70 ft. beam, and a displacement of 12,550 tons. Her triple expansion four-cylinder engines, built at Indret, are to develop 27,500 h.p., giving her a speed of 22 knots. Her armour consists of a complete hardened belt extending to 7½ ft. below the water-line, of 6-in. thickness amidships, tapering to 3·6 in. forward, and 3·2 in. aft. There is an upper belt of 5 in. to the maindeck, rising to the upper deck forward. The main turrets have 8-in. protection, as has the conning tower, while the secondary turrets are of 5·5-in. plates. Her main armament consists of four 7·6-in. breechloaders, mounted in pairs in the main turrets fore and aft, and sixteen 6·4-in. quick-firing, of which twelve are mounted in pairs, six on each side of the broadside, while four are mounted singly in the maindeck casemates. There are, in addition, twenty-four small guns and five torpedo tubes. The estimated cost of these vessels is £1,170,000.

The armoured cruiser *Sully* and *Marseillaise*, both of which are fitted with Belleville boilers, have carried out a most satisfactory series of trials. The *Sully*, at a 24 hours' half speed trial, developed 10,340 h.p., and her coal consumption worked out at 1,265 lb. per unit of power per hour. The *Marseillaise*, on a similar trial, developed 10,658 h.p., burning 1,325 lb. of coal per h.p. developed. At a further trial, she develloped 14,593 h.p., and on this occasion, the coal consumption was 1·4 lb. per unit of power per hour. The figures are those given by the contractors, and differ slightly from those I gave in my notes for July.

In small craft trials during the past month, the most notable performance was that of the destroyer *Carabine*, which developed 6,429 h.p., as against 4,800 contracted for, and attained a speed of over 30 knots as against the 26 knots designed for this class. All efforts to refloat the *Espingole* have failed, and it is to be supposed she will be abandoned.

RUSSIA.

The *Césarévitch*, to which I have had occasion to refer several times lately, is being hurried forward for commissioning, when she will be despatched to the Far East, whither the *Oslabia*, recently completed, has already been despatched. The *Césarévitch* is 390 ft. in length, with a beam of 75½ ft. Her mean draught is 26¼ ft., and her displacement 13,110 tons. Her hull and accessories take up 5,125 tons of this, while her armour takes another 3,560. Her artillery and torpedo apparatus again account for 1,540 tons, while yet another 1,430 tons is allowed for her engines and boilers. Her maximum coal capacity is 1,350 tons, and her radius of action 5,500 knots. Her protection consists of a complete belt of armour from one and a-half feet above to five feet below the water-line, varying in thickness from 10 in. to 6 in. Above this, again, is an upper belt of 6 in. plates. There are also two armoured decks, the upper one of which is of 2·7 in. and the lower one 1·5 in. armour. At

about six feet from the side this lower deck joins an interior plating, also 1·5 in. thick, which descends to the double bottom, and is intended to protect the outer surface from torpedo-boat attack. The barbettes for the heavy guns have 10-in. armour, the secondary turrets having 6-in. armour plating. The ammunition chambers are situated in the hold of the vessel underneath each turret, and the hoists are well protected.

The armament consists of four 12-in. 40 calibre breech-loaders, mounted in pairs in revolving turrets fore and aft, and twelve 6 in. quick-firers mounted in pairs, one pair at each corner of the citadel fore and aft, and two on each of the broadsides. All these guns have a very large arc of fire. Besides these there are twenty 12-pounder, twenty 3-pounder Hotchkiss, ten Maxims and two light guns. The torpedo tubes are four in number, two being submerged and two above, placed fore and aft. The two sets of four-cylinder triple expansion engines are supplied with steam by twenty Belleville boilers with economisers. Electricity enters largely into the internal working of the ship, all the turrets, ammunition hoists, steering apparatus and lighting arrangements being actuated by this means. She is taking in her armament and stores at Sebastopol, these having been forwarded from Cronstadt.

August was a very busy month with Russian shipbuilders, no fewer than four vessels taking the water during that month. The *Slava* battleship, which was launched at the Baltic Yard, St. Petersburg, in the presence of the Tsar, on August 29th, is the last of the *Borodino* class to leave the stocks. Her length over all is 398 ft. 1 in.; between perpendiculars, 367 ft. 5 in.; beam, 76 ft.; draught, 26 ft.; displacement, 13,516 tons. Her engines are to develop 15,800 h.p., and will be supplied with steam by twenty Belleville boilers. The speed is to be 18 knots. She will carry 62 guns, consisting of 12-in., 6-in., 2·95-in., 1·85-in., 1·45-in., and 2½-in. The 12-in. and 6-in. guns will be placed in turrets. The *Slava* was laid down on October 4th, 1902, and when launched, 67 per cent. of her had been built in. On the same day was launched also at the Baltic Works, the new Imperial yacht, *Alexandria*, of 500 tons. This vessel will be added to the list of ships belonging to the Baltic Fleet. The first-class cruiser *Oleg*, and second-class cruiser *Jemchug*, were launched in the presence of the Tsar, at St. Petersburg, on August 27th. The length of the *Oleg* is 439·5 ft.; beam, 54·5 ft.; draught, 20·7 ft.; displacement, 6,675 tons. Her engines, of 19,500 h.p., will be actuated by steam from sixteen Normand boilers, and will give her a speed of 23 knots. She will carry twelve 6-in. guns—four in pairs in turrets, four in casemates, and four on deck; the remaining guns will be 2·95-in., 2·5-in., 1·85-in., and 1·45-in., and there will be three machine guns; her two torpedo tubes will be both submerged. She was laid down in November, 1901. The length of the *Jemchug* over all is 364 ft. 9¼ in.; beam, 40 ft.; draught, 16 ft. 4¾ in.; displacement, 3,106 tons. Her speed will be twenty-four knots, obtained by engines developing 17,000 h.p., and supplied with steam by sixteen Yarrow boilers. She will carry six 4·7-in., six, 1·85-in., two 1·45-in. guns, and one 2½-in. landing gun. It is expected that a sister ship the *Izumrud* will be launched before the middle of October.

The Nikolaevski Shipbuilding Works have received the order for three new torpedo-boat destroyers, the *Zadorni*, *Zorki*, and *Zvonki*, for the Russian Black Sea Fleet. Three other torpedo-boat destroyers, the *Blestiashchi*, *Bezuprechni*, and *Buistri*, have been completed, and have left for the Far East. Five torpedo boats of the *Cyclone* type, built at the Newsky Yard, are now completing for sea. Fifty-four Russian destroyers have recently been re-named.

UNITED STATES.

No battleships have been launched during the past month, but progress on those already in the water continues to be rapid. The *Missouri* should shortly be ready for commissioning. The race between the New York Navy Yard and the Newport News Company with the building of the *Connecticut* and *Louisiana*, respectively, is becoming a rather one-sided affair, the latter vessel being, at the time of writing, 19 per cent. completed, and the former but 13 per cent. Work on the *Vermont*, *Kansas*, and *Minnesota* has not yet begun.

Turning to armoured cruisers, the *Pennsylvania* has been launched. This vessel is of the *California* class authorised in June, 1899. The *Pennsylvania* was laid down at Cramp's Yard in September, 1901, and took the water on August 22nd last. The following are her dimensions and general features: Length, 502 ft.; beam, 70 ft.; displacement, 13,800 tons; mean draught, 24 ft. 6 in.; draught at full load, 26 ft. 6 in. Provision has been made for a total bunker capacity of 2,000 tons. The *Pennsylvania* will be propelled by twin-screw, four-cylinder, triple-expansion engines of 23,000 h.p., having a stroke of 4 ft., and running about 120 revolutions per minute. To provide steam there are thirty boilers in eight separate water-tight compartments, representing a total of 1,590 square feet of grate surface and 68,000 square feet of heating surface. These boilers are allowed 250 lb. pressure, and the cruiser is expected to make 22 knots. Her armament will consist of four 8-in., fourteen 6-in., and thirty-six smaller guns. The heaviest guns will be mounted in pairs in turrets forward, and aft, and the 6-in. pieces will be disposed five on each broadside. The armour belt, 6 in. in thickness, will extend over 244 ft. of the vessel's length, and at each end will be 4 in. bulkheads, the whole forming a citadel in which are the 6-in. guns behind 5-in. casemates. The turrets for the 8-in. guns will have a uniform thickness of 6 in., and the conning tower will have 9-in. protection.

The cruiser *Des Moines* has undergone satisfactory preliminary trials, and further sea trials are to take place. The protected cruiser *Cleveland*, on her full-power trial, attained a speed of 16·45 knots, which is ·05 knots lower than the contract speed. As, however, the behaviour of the engines gave great satisfaction, it is expected that the vessel will be accepted.

Four submersibles of a new double-hulled type, are to be built by Messrs. Neafie and Levy. It is claimed for these vessels that the vital portions are absolutely immune from gun-fire, and a model recently tested attained a speed of 16 knots.

LOCOMOTIVE ENGINEERING NOTES.

BY CHARLES ROUS-MARTEN.

More "Atlantics."

Evidently the "Atlantic," or "4-4-0" class of locomotive is to be the future standard type of the Great Northern Railway, if not of its associate in the East Coast Anglo-Scottish service, the North-Eastern, also. Mr. H. A. Ivatt, the chief mechanical engineer of the Great Northern, was the absolute pioneer in Britain in the introduction of this style of engine. He began with a "sample" engine long well known as No. 990. After a lengthened trial of this engine, he built ten more, all numbered in the "900's." Quite recently Mr. Ivatt has added another eleven—Nos. 250-260—of which Nos. 250 and 252-260 are practically identical with No. 990, save in being framed to carry an extra large boiler, which at present, however, is fitted only to No. 251. But the big boiler has already proved so decided an advantage that no fewer than twenty more of this class are to be put in hand at once and built at the Doncaster Works.

A Remarkable Change.

It is noteworthy that almost simultaneously with this newest departure on the Great Northern there is a further advance along the path of deviation from Great Northern traditions of the past. The order for twenty new "Atlantics," bringing up the total to forty-one, further emphasises the fact that the Great Northern express type of the future is to be of the coupled order, as on the Great Western. Those two railways, which, from their original inception, have maintained and raised the British reputation for speed, have always been the particular home and nursery of the single-wheeler type. Yet now it is probable that each has built its last single-wheeler, unless, indeed, it should be deemed worth while to turn out a few occasionally for specially light fast work. But for the standard heavy express service single-wheelers are obviously doomed, excepting, perhaps, in the case of the Midland, and even that is a doubtful exception. When Mr. Ivatt completed his dozen new 7-ft. 6-in. "singles" there seemed a chance that the type might even yet survive. But deficient adhesion is a fatal drawback in these days of big boilers and cylinders, which are useless unless combined with adhesion-weight sufficient to utilise the power they yield.

Doomed Veterans.

Still, few people who can appreciate beauty of design and excellence of performance will fail to view with regret the rapid disappearance of those graceful and beautiful engines, the 8-ft. single-wheelers designed by the late Mr. Patrick Stirling in the year 1869, and built by him up to the time of his lamented death in 1896. There were 53 in all, the first 47 having 18-in. cylinders, and the last six 19½-in., all having 28-in. piston stroke and 8-ft. 1½-in. single driving wheels. It was a curious reversal of the usual course that whereas the earliest of them had 1,165 square feet of heating surface, the later ones were given successively only 1,045, and finally 1,031 square feet. These last were the six with 19½-in. cylinders. To attempt to fill cylinders of the colossal cubical capacity given by such dimensions as 19½ in. by 28 in., with a boiler having only 1,031 square feet of heating surface would seem at first sight a manifest absurdity. Yet so paradoxical do the conditions of locomotive practice often appear, that these engines with their vast cylinders and wheels and tiny boilers, have done and still do much excellent work. The skilful disposition of his limited heating surface by the able designer must be looked to as the theoretical explanation. No fewer than fifteen of these veterans, whose ages range up to nearly forty-four years, have now gone to the scrap heap, viz., Nos. 2, 3, 47, 48, 60, 62, 69, 546, 547, 549, 550, 662, 771, 772, and 777.

A "Glorious Past."

It is not too much to say that these engines have had a glorious past, and have been largely instrumental in sustaining during the quarter of a century extending from 1870 to 1895 British supremacy in respect of railway speed. During those years the Great Northern virtually led the whole world as regarded swiftness, and were it possible that train loads could be kept down to the point of that period, it is highly probable that the 8-ft. singles which won and sustained that leadership would still be employed with such modifications as might suit the altered conditions. But two obstacles have stood, and stand, in the way of their continued employment on the most important present-day expresses. In the first place, the height of an 8-ft. wheel practically prohibits the use of a boiler of the diameter necessary in these times to enable sufficient steam to be furnished. Secondly, even if an adequate boiler could be got in above the axle of 8-ft. wheels within the limitations of the British loading gauge, it would not be possible to give the wheels sufficient adhesion-weight to "take up" the power supplied from the boiler. And so these splendid veterans have to go. It may be thought that a use could still be found for them on lighter expresses, or even on branch work. But, unluckily, the light express is getting more and more a rarity on the Great Northern as on other main lines, and the design of the 8-ft. single is not one at all suited to branch traffic. Several of them have been rebuilt by Mr. Ivatt with boilers as large as could be conveniently fitted, and these continue to do useful work, notably when required to give pilot assistance. But their scope in this respect is becoming more and more limited with the introduction of powerful coupled engines, and so the melancholy fact has to be faced that their race is a doomed one.

The Problem of Driving-Wheel Diameter.

It is very doubtful whether we shall ever again find an 8-ft. driving-wheel employed in locomotives. It would probably be safe definitely to assume the negative unless under some entirely fresh set of conditions. Since Mr. Stirling's death that size has only

Locomotive Engineering Notes.

once been tried, namely, in the [illegible] extraordinary Thuille monstrosity exhibited by the builders, Messrs. Schneider, of Creusot, at the Paris Exhibition of [illegible] and that engine was [illegible] failure. It is, indeed, difficult to see why any modern designer should deliberately accept so material a loss of tractive power as is involved in employing a wheel of such a large diameter. A few advantages which it confers in the way of diminished piston velocity and less frequent filling and emptying of the cylinders are purchased at a disproportionately high price in the shape of drawbacks. Indeed, it has long appeared to the present writer that the principal merit of the 8-ft. wheeler, or, perhaps, it would be better to say, its principal recommendation to public opinion, was a purely spectacular one; a large wheel suggests swiftness, but this may be largely due to the fact that 8-ft. wheels were extensively employed by the railway which first set the example of high speed, namely, the Great Western, with its 7-ft. gauge. Strangely enough, it has never happened to the writer in all his exceptionally large experience to obtain his best maximum speed records with an 8-ft. wheeler. He has a vast number of timings with as many as fifty Great Northern 8-ft. wheelers, as well as with many of the Great Western 8-ft. wheelers of broad gauge days; yet he never succeeded in recording speeds even approaching those which he has obtained with smaller single-wheels and still smaller coupled wheels. It is not suggested or implied that this is a case of cause and effect; the fact is simply noted as an interesting one. Even on the Great Northern he has noted higher speeds with a 7-ft. 6-in. than with an 8-ft. wheel, and on the Great Western and Midland with 6-ft. 8-in., 6-ft. 9-in., and 7-ft. coupled wheels, he has registered higher velocities than he ever obtained with the 7-ft. 6-in., 7-ft. 8-in., and 7-ft. 9-in. single-wheelers so largely used on those lines. In this connection it is noteworthy that while the Great Northern is "cutting up" its 8-ft. wheelers at such a rapid rate, it is not as yet condemning any of the 7-ft. 6-in. singles, several of which are quite as old as some of the scrapped 8-ft. engines. The Stirling 7-ft. 6-in. wheelers, which number twenty-three altogether, are all being maintained, and ten have been re-boilered. But one feature of the Doncaster programme which in relation to the scrapping of so many 8-ft. wheelers seems at first sight peculiar, is that the much older 7-ft. class, first brought out in 1867, are all being kept up, some having been thoroughly rebuilt with new and larger boilers. Nos. 21, 41, and 61 were thus treated some time back, and No. 55 has just come out in a like new guise. But here, again, the reason is fairly obvious. The 8-ft. engines had to go because they were only suited to a particular service now grown beyond their powers. The 7-ft. [illegible] turned to valuable account in working branch line and other services which are well within their means. It would seem like a whimsical paradox to say that the only one of the 7-ft. class which has been broken up is the one with 7-ft. 6-in. wheels, and yet such is the case. No. 92 was identical with the others, excepting in being fitted with the discarded pair of 7-ft. 6-in. wheels originally belonging to Mr. Archibald Sturrock's once-famous engine, No. 215, built in 1853. No. 92 was long deemed the swiftest engine on Great Northern metals, but with 7-ft. 6-in. wheels and cylinders 17½ in. by 24 in., her tractive force was too low for present-day usefulness, and so she went to the scrap-heap, her number now being borne by one of Mr. Ivatt's newer 7-ft. 6-in. single-wheelers.

Eight-wheel Coupled Goods Engines.

While dealing with Great Northern locomotives and with recent departures and plans at the Doncaster Works, it may be interesting to mention that the large eight-wheel-coupled goods engines recently introduced by Mr. Ivatt are to be multiplied. They have proved, as might have been expected, such extremely useful machines for main line heavy goods work that there is little doubt of their ultimately superseding all other types for that particular duty, although plenty of room will still remain for the six-coupled type. But many of the older six-coupled goods engines on the Great Northern Railway, particularly the outside-framed class of Mr. Sturrock's day, have now served their time, and are being broken up. Indeed, it may be said that practically all the old outside-framed goods engines are condemned, and will be scrapped as soon as they next stand in need of any heavy repairs. Another goods type once of high celebrity is also on the condemned list of the Great Northern, namely, the mineral engines designed and built by Mr. Patrick Stirling some forty years ago, which were given cylinders of enormous dimensions, viz., 19 in. by 28 in. Indeed, those that remain have had their cylinders bored out until the diameter of 19½ in. to 19¾ in. has been reached, making them the largest cylinders ever seen even on the Great Northern Railway. They have good done service in their time, but in their heyday the sidings were not long enough to accommodate the huge coal trains they could haul, and now that provision is made for longer trains, they have lived their life, and become obsolete. So they are being broken up, and twenty more of the eight-coupled 401 Class are being put in hand by Mr. Ivatt at the Doncaster Works, to perform a duty similar to that for which the discarded engines were originally designed.

WORKSHOP PRACTICE.

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

NEW HACK SAWS.

A NEW form of motor-driven hack saw is being introduced by Messrs. Edward G. Herbert, Ltd., of Manchester. This is a quick-cutting concentric sawing machine, the cutting speed of which is increased by running the machine at double the ordinary speed and using a rotary pump to supply the blade with water. It is capable of cutting bars and girders up to 12 in. by 8 in. The motor is of the wholly-enclosed constant-speed type, specially wound for a speed of 600 revolutions per minute, giving ½ h.p. at that speed. Chain gearing is employed, having a ratio of six to one, making the actual speed of the machine 100 revolutions per minute. The machine is entirely self-contained and is portable, having all the necessary switches attached. Power can be taken from any source of supply by means of a flexible conductor and a lampholder plug. It is claimed that the machine will be found of excellent service, not only where electric driving is in use, but for all purposes where no shafting is available, and electricity is used for lighting.

ELECTRICITY IN ROLLING MILLS.

The use of electricity in rolling mills has brought about some remarkable changes, and it is interesting to note that Mr. Alva C. Dinkey, who has played an important part in this development, has been elected to succeed Mr. W. E. Corey as president of the Carnegie Steel Company. Mr. Dinkey, in 1891, entered the Carnegie service for the second time, as a clerk in the general superintendent's office, at Homestead. Conceiving the possibilities of electricity in rolling mills, he sought a position in the works; the result being one of the most important evolutions in steel works and rolling mill practice. The method of working blooming and other heavy rolling mills prior to Mr. Dinkey's innovations required a considerable force of workmen, using hooks to guide the material through the rolls. Mr. Dinkey perfected appliances to drive the rolls of the feed tables and other devices which dispensed with the use of hooks and tongs, greatly reducing the working force, and the cost of production. He was one of the first to introduce electrical cranes in rolling mills and assisted in the development of the electrical "charging machine" for charging ore, scrap and other stock into open-hearth steel furnaces. He holds patents on one type of charging machine, and is the inventor of the electrical controller bearing his name which is so largely used in steel works; also a novel device for actuating the tongs of a "soaking pit" crane, a machine for drawing slabs and other unfinished forms from heating furnaces. In 1898 he was appointed assistant general superintendent of the Homestead works, and in March, 1901, he succeeded Mr. William E. Corey as general superintendent at Homestead. In his present position he will have a still larger sphere of action.

THE STRENGTH OF MODERN LATHES.

Some idea of the strength and stiffness embodied in modern lathes may be gained from the fact that a recent lathe, using four tools, has reduced a steel shaft from 36 in. to 28 in. in diameter with a feed of ¼ in. That is to say, the depth of the cut was 1 in., this depth being divided among the four tools. In such heavy cuts as this a question arises as to the relative economy of forging more closely, or of reducing by turning a shaft forged only approximately to size; and it has been found, says the *Iron Age*, that when the cost of the hammer used in forging such large shafts is considered, together with the furnace and fuel, and when it is considered that from ten to twenty men are required to operate such a hammer, there is greater economy in forging the shaft approximately to shape and diameter, and then reducing it in a lathe made especially for the purpose, as this lathe was.

A LARGE VERTICAL MILLING MACHINE.

One of the largest vertical milling machines ever constructed has been designed and built by the Newton Machine Tool Works, Philadelphia, Pa., for the American Locomotive Company. It is intended mainly for machining guide yokes—of which a stack can be clamped on the table and finished without resetting. The machine is adapted to any heavy class of milling, and is arranged to be driven by either a belt or a direct-coupled motor. It has six changes of automatic feed which can be reversed, and the carriage, being so heavy, is arranged for a power-feed for all movements. The crane which is provided for handling the work, swings on the centre of the spindle. The carriage of the machine is 60 in. in diameter over tee slots and 70 in. outside diameter. The spindle is 6 in. in diameter, and the distance from centre of spindle to column is 50 in., and will admit work 24 in. high. The carriages have a cross feed of 65 in. and an in and out feed of 50 in. The spindle, being counterweighted, can be quickly adjusted to any desired position, and there is also provided a hand feed to spindle where it is necessary to use the machine for boring. The shipping weight of the machine is about 60,000 lb.

GIGANTIC CRANE.

One of the largest cranes manufactured in recent years is that completed by the Brown Hoisting Machinery Company for the New York navy yard. The crane is supported upon a steel pontoon 100 ft. long, 60 ft. wide and 11 ft. deep. The runway on which the trolley travels is over 200 ft. long, projecting at either end about 50 ft. The cables are of sufficient length to enable the crane hooks to be lowered to a depth of 20 ft. below the water level, and the structure is tall enough so that they can be raised to a height of 65 ft. above the water. The pontoon is divided into three main longitudinal compartments. On one side are the boilers, on the other side the steam capstans, and in the centre is a counterweight weighing 250 tons. In floating cranes it has generally been customary to keep the pontoon level and the crane in an upright position by filling or emptying large water tanks placed at either end when heavy weights were to be lifted. In this crane, however, the very novel plan is adopted of a moving counterweight, which travels on four tracks. A pair of cables is used for each crane hook; that is the tackle blocks and sheaves are all double with two complete sets. The rated capacity of the crane is 100 gross tons, but it can easily handle a larger weight at the extreme ends of the arms, while at or near the centre of the pontoon it can hoist a still greater weight.

POWER STATION NOTES.

BY A CENTRAL STATION ENGINEER.

The Passing of the Corliss Valve.

It almost looks as if the [illegible] of the quick-speed engine, the steam turbine and the gas engine is causing the makers of the slow-running engine to cheapen their manufactures as much as possible. At any rate there is a tendency towards simplification of design, and this shows itself in the return to simple drop valves, the *single* crank engine, etc. Personally, the writer never could see the wonderful claims that have always been associated with the Corliss cut-off gear. The word Corliss is euphonious and has a good advertising value. The writer does not say that the gear does not do its work well, but rather that there are simpler and cheaper means of arriving at as good a result. "As good a result" is written advisedly, because is it not a fact that the Sulzer engines, acknowledged to be the best slow-running engines in the world, have always done without Corliss valves. Some of the most reputable firms in the country, in East Anglia for example, have also got along very well without following the prevailing fashion of borrowing second-hand American ideas.

Another matter which is telling seriously against the Corliss cut-off valve is the increasing employment of superheated steam. Even with such a moderate superheat as 100 deg. F. the valve is not satisfactory, and for a higher degree of superheat it is hopeless.

It may, of course, be urged that the claims of superheating are overstated. It may be so, but the writer has had some experience in the matter, and is convinced that the main idea is right, and is bound to come along rapidly. In any case, however, what with the quick-speed engine, the steam turbine, gas engine, etc., the slow running engine is now entering upon a fight for its life as it were, and everything must be simplified to the last degree.

The Money Value of a Low Steam Consumption.

It is to be feared that in adjudicating a number of engine or steam dynamo tenders too much notice is paid to lowness of price and too little to the questions of steam economy and efficiency. As a matter of fact, if looked at in the proper light, a low steam consumption has a very real financial value which, if taken cognisance of, will often show that what is apparently a high tender is in reality a very reasonable one.

Take, for example, two 500-kilowatt steam generators, in which the difference in steam consumption is, say, 3 lb. per kilowatt hour. It may be that one is a quick-speed engine, and the other a slow-speed engine, the latter, with the foundations and additional space, etc., being, of course, the more expensive set. If they are for traction purposes we may take it that they will be in continuous use for fifteen hours per day all the year round. Now if the boilers supplying the sets are capable of evaporating 10 lb. of water per pound of coal, and the coal costs 15s. a ton, then the saving in coal per annum will be

$$\frac{500 \text{ kw.} \times 2 \times 3 \text{ lb.} \times 15 \text{ hrs.} \times 365 \times 15\text{s.}}{10 \text{ lb.} \times 2{,}240 \times 20\text{s.}} = £550.$$

This saving, when capitalised at 5 per cent., gives

$$\frac{£550 \times 100}{5} = £11{,}000,$$

which is a very handsome amount, and will go a long way towards wiping out any difference in first cost. Of course in a new station, besides the two sets above mentioned there would be a third stand-by set, which would reduce the figure £11,000 in the ratio of 3 to 2, or if there are four sets then it would be in the ratio of 4 to 3.

It should be noted that the boiler evaporation enters prominently into the above equation, and what is true of the engine as to economy of work is also true of the steam boiler. In any case enough has been written to show the importance of relying on proper expert advice in the adjudication of tenders, whether it be a private or a municipal installation. The writer fears that in too many cases the question of low first cost is practically the only deciding factor.

The Care of Oil Engines.

For country house lighting and the smaller isolated installations the oil engine is eminently suitable, but of all engines it is perhaps the one which requires most humoring. Once get it into good fettle, however, with the right kind of oils, the circulating water properly proportioned, etc., and an intelligent man as driver, and the oil engine is a most satisfactory prime mover. A frequent cause of trouble with the oil engine is the sticky piston, but this can be always traced to the use of improper lubricating oil. In one case the writer knows of, the engineer had previously had experience in Stockport gas engines, and he naturally thought that the special oil sold for that engine would be suitable for oil engines. In another case no provision was made for draining the engine bed, with the result that the crank and its balance weight splashed a quantity of ordinary mineral oil from the bearings into the open end of the cylinder—result, sticky piston and much bad language. The oils which are most suitable for oil engine cylinders are olive oil and cotton seed oil, and in connection with the latter it may be interesting to mention that its special suitability was the result of an accident at the old Trusty Engine Works at Cheltenham. Some cotton seed oil had been ordered for another purpose, and it was used for one engine quite accidentally. At first sight the oil looks as if it would be most unsuitable for such a purpose. To everyone's surprise it proved a complete cure to the sticky piston troubles which, until then, had been the most serious difficulty the company had to contend with.

As the heat from the cylinders assists in keeping up the temperature of the ignition tube it is important that at low loads there should not be too much circulating water, otherwise the cylinder may get too cool. Below quarter load, in fact, it is frequently necessary to apply a lamp or some external heat to the ignition. It has occurred to the writer that this could be dispensed with by throttling the circulating water as the number of explosions become reduced. Another way would possibly be to baffle the water from circulating round the firing end of the cylinder.

This reminds the writer that in both oil and gas engines the entrance and exit of circulating water round the cylinder does not receive the attention it deserves. It will be readily seen that under certain circumstances if a plain round pipe is fixed to about the centre of the water jacket on the under side and another similar pipe is fixed at the top and also in the centre, as the water is circulated by convection currents it naturally takes the shortest course, and it may be that the water will form into distinct eddies at the ends of the jacket. The writer believes many troubles can be traced to this cause.

SHIPBUILDING NEWS.

The Cruiser "Cumberland."

An interesting incident of the early days of September was the completion of the official steam trials of the cruiser *Cumberland*, built by the London and Glasgow Shipbuilding and Engineering Company, Ltd., at Glasgow. The results exceeded in some respects even the performance of the *Berwick* and *Donegal*—hitherto the fastest of Clyde-built armoured cruisers. The *Cumberland*, on her full-power trial, averaged for eight hours' steaming between Ailsa and the Cambraes, a speed of 23·7 knots, which is practically the same speed as the *Donegal* and the *Berwick*. All three ships are, therefore, great successes. The mean power indicated by the twin engines in the *Cumberland* was 22,769 h.p., and the average number of revolutions per minute was 145. On the thirty hours' trial at continuous steaming power the *Cumberland* attained the speed of 22·5 knots, the engine making an average of 133 revolutions and indicating 16,400 h.p. At one-fifth power the speed was 15·8 knots, with the engines making 90 revolutions, and indicating 4,674 h.p. The vessels of this class previously tried made only 22·30 and 14·75 knots at these respective powers. The coal consumption of the *Cumberland* on all three trials was within 2 lb. per i.h.p. per hour. The *Cumberland* will be completed at the London and Glasgow Company's works in accordance with the new Admiralty policy—not at the dockyards.

Progress of British Shipping.

From official returns, we gather that 368 steamers, aggregating 551,898 tons gross, and 210 sailing-ships, aggregating 22,814 tons register, were added to the register of the United Kingdom in the first seven months of the present year, as compared with 485 steamers, of 759,500 tons, and 175 sailing-ships of 31,919 tons, in the corresponding portion of 1902. The removals in the same period were 178 steamers, of 247,686 tons, and 216 sailers of 51,080 tons, against 203 steamers, of 235,407 tons, and 252 sailers of 52,707 tons in 1902. The net addition to the British register has thus been 184 vessels, and 275,946 tons, which compares with 205 vessels, and 503,305 tons a year ago :—

Additions to Register of United Kingdom.

		1903.		1902.	
January	..Steamers..	42	98,010	145	111,331
	Sailing Ships	21	6,701	23	1,840
February	..Steamers ..	39	63,627	37	96,455
	Sailing Ships	15	3,653	14	7,980
March	..Steamers..	54	71,888	49	89,154
	Sailing Ships	44	3,078	31	6,478
April ..	..Steamers ..	49	81,688	54	92,193
	Sailing Ships	26	2,907	22	7,868
May ..	..Steamers ..	58	78,990	67	132,438
	Sailing Ships	27	1,311	28	1,854
June ..	..Steamers ..	51	73,581	70	114,380
	Sailing Ships	41	2,531	40	5,290
July ..	..Steamers ..	75	84,114	63	123,549
	Sailing Ships	36	2,633	17	609
		578	574,712	660	791,419

On the other hand, the following were the removals from the register of the United Kingdom :—

		1903.		1902.	
January	..Steamers ..	25	33,647	21	26,854
	Sailing Ships	33	8,412	45	6,411
February	..Steamers ..	22	24,804	37	35,508
	Sailing Ships	34	4,065	53	7,507
March	..Steamers ..	30	37,349	30	45,867
	Sailing Ships	33	4,933	33	8,184
April ..	..Steamers ..	27	36,229	41	50,679
	Sailing Ships	35	8,974	43	10,889
May ..	..Steamers ..	37	62,637	24	23,793
	Sailing Ships	36	11,327	23	5,537
June ..	..Steamers ..	13	15,485	23	28,312
	Sailing Ships	18	7,847	18	3,850
July ..	..Steamers ..	24	37,535	26	24,394
	Sailing Ships	27	5,522	37	10,329
		394	298,766	454	288,114

Further official returns showing the tonnage of sailing and steam vessels of different nationalities with cargoes and in ballast entered and cleared in the foreign trade at United Kingdom ports, while indicating a remarkable advance of British shipping in the last two decades, point to a slight diminution in the proportion of British to the total tonnage. In 1880, British ships amounted to 41,348,984 tons out of a total of 58,736,063, or 70 4 per cent. of the whole ; whereas last year the figures were 64,902,907 British and 34,969,812 foreign, *i.e.*, the British percentage was 65. For steam vessels only in 1880 the British percentage was 83·2, but last year, although the tonnage had more than doubled, it had fallen to 67·7. The following shows the variations in the last ten years in the trade with the chief foreign nations :—

	Seven Months.	
	1893.	1902.
	Tons.	Tons.
United States ..	5,305,744	7,167,774
Germany	3,836,265	5,610,030
France	5,192,568	5,509,088
Holland	3,695,201	5,148,592
Belgium	2,491,785	3,903,452
Spain	2,623,977	3,333,827

The tonnage of vessels from British possessions rose from 4,379,459 tons in 1893 to 6,172,009 tons in 1902. The following are the principal figures for vessels cleared from British ports :—

	1893.	1902.
To	Tons.	Tons.
United States ..	4,581,236	6,703,410
France	4,297,822	5,765,253
Germany	3,732,169	4,627,012
Italy	2,325,176	3,276,872
Holland	2,069,211	2,607,754
Belgium	1,598,367	2,561,871

As to ships entered and cleared at our ports in the trade with British possessions, in 1853, British vessels accounted for nearly seven-eighths of the total (4,033,651

tons), and last year aggregated 11,877,400 out of 13,224,859 tons. The tonnage of sailing and steam vessels entered and cleared with cargoes and in ballast in the foreign trade of the undermentioned foreign countries last year shows the percentage under the national and British flags :—

	Tons.	Flag. National. Per cent.	Flag. British. Per cent.
United States	48,603,839	16·4	50·8
Italy ..	42,320,578	40·4	[illegible]
Spain ..	20,994,495	48·6	20·6
Germany ..	20,493,043	40·8	27·7
Belgium ...	20,246,022	12·8	43·8
Russia ..	19,549,000	8·2	91·8

Some of the Colonial figures are :—

	Tons.	British.	Foreign.
Canada ..	14,731,488	59·8	40·2
Cape ..	12,511,691	88·4	11·6
Natal ..	3,833,011	89·4	10·6

The following is the registered tonnage of the merchant navies of the British Empire and the United States for last year :—

	Tons.
British Empire	11,566,745
United States	5,797,902

During the last ten years there has been a steady increase in the number of foreigners employed in British ships. In 1893 the proportion of foreigners to every 100 British persons employed was 15·83, and last year it rose to 22·82.

New Turbine Steamers.

The turbine steamer has come to stay. In addition to the boats now successfully at work on the Clyde and English Channel, the Union Steamship Company of New Zealand have contracted with Messrs. Wm. Denny and Bros., Dumbarton, for the construction of a turbine steamer for their service between Melbourne and Launceston, Tasmania, under the contract recently made by the company with the Federal Government. The vessel is to be 300 ft. in length, by 43 ft. beam, and is to be capable of maintaining a sea speed of 18 knots. The run between the two ports will be made, wharf to wharf, in about sixteen hours. The turbine steamer *Queen*, on the English Channel service, runs a distance of 21 miles, but 276 miles will be run by the Union Company's new steamer. The introduction of the turbine steamer into Canada is being negotiated by Messrs. Brown, McFarlane and Co., of Glasgow, who are making arrangements with the Canadian Pacific Railway Company for the installation in that company's lake boats of turbines, which will have the effect of reducing vibration to a minimum. The fleet of the Stranraer and Larne Steamship Company is also to be increased by a new turbine steamer, the order for which has been placed in the hands of Messrs. William Denny and Brothers, Dumbarton. The new vessel is designed to make the passage between Stranraer and Larne in considerably less time than the present steamers, which will be a great advantage. The new steamer is to be ready in time for the extra service commencing in June next year.

A Notable Combine.

The shipbuilding combine of Wigham-Richardson and Co., Ltd., and C. S. Swan and Hunter, Ltd., referred to in our July number, is being enlarged by amalgamation with the Tyne Pontoons and Dry Docks Company, Ltd., whose premises are situated between those of the two other combined concerns. The Tyne Pontoons Company's are the largest existing dry docks on the Tyne, and have excellent shipbuilding facilities. The Combine will now include two splendidly equipped shipyards, one engineering works, a controlling interest in the Wallsend Slipway and Engineering Company, and dry docks and pontoons equal to the best on the Tyne. By the inclusion of the Tyne Pontoon and Dry Docks Company into the Swan, Hunter and Wigham-Richardson Combine the new company will be one of the largest and best equipped shipbuilding, engineering and repairing concerns in the kingdom. In May last C. S. Swan and Hunter, Ltd.; and J. Wigham-Richardson and Co., Ltd., amalgamated into one concern with a capital of £1,500,000, divided into 800,000 ordinary shares of £1 each and 700,000 preference shares of £1 each, of which the former company received £564,750, partly in ordinary and partly in preference capital ; while the latter received 206,225 ordinary and 158,025 preference shares, or £364,250. By the articles of association the new company was empowered to acquire shares in other concerns, and effected an arrangement with the Wallsend Slipway and Engineering Company, Ltd., by which it purchased 50,000 preference and about 100,000 ordinary shares of £1 each, thereby giving the new company a working and controlling interest. The Tyne Pontoons and Dry Docks Company's capital, as reconstructed in 1900, consists of 89,630 £1 ordinary and 89,650 £1 preference shares, both fully paid, or £179,280 in all.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Search Light Carbons.

It is a significant but little known fact that German-made searchlights are very largely used by the British War Office. The Schuckert manufacturers in this line have deservedly won unequalled reputation, and ours is not the only Government which goes to this firm for its searchlights and carbons. Searchlight carbons are very special, and it has been pointed out that our position might be somewhat awkward in case of war, for as matters stand at present there are only two are lamp carbon works in this country, namely, at Brymbo and Witton. The first are small works, and the second, only recently started, are working at a loss, so that the proprietors threaten to close them unless there is protection against the Continental carbon trust. This would be a pity, as there is no doubt that in case of war we should be placed at a disadvantage. for searchlight carbons, and seeing that the bulk of the raw material which the Continental firms use, comes from this country, it should be possible to manufacture cheaply here. It may be interesting to give some particulars of searchlight carbons. In the Schuckert lamp, for example, having a 3-ft. diameter parabolic mirror 450 millimetre focal length, the carbons carry 150 ampères, and have the following dimensions :—

Positive, 38 millimetres, diameter, 11 in. long, with soft carbon core.

Negative, 26½ millimetres, diameter, 9 in. long, with *copper* core.

The carbons are placed horizontally, and in order to prevent the arc flaming upwards the carbon points are partly surrounded by a semi-circular piece of soft iron, the magnetic field of which keeps the arc central. The section of this iron is so proportioned that the 150 ampères flowing in the carbons acts as a single turn, or, in other words, there are 150 ampere turns.

The Report on Municipal Trading.

The Report of the Joint Committee of the House of Lords and House of Commons on Municipal Trading has now been issued, and is interesting reading to all engineers, but particularly those engaged in electrical work. In this country it has been the fortune, or misfortune, for electrical engineering to develop alongside the municipal trading idea, with the result that it has been seriously affected by it. At any rate a good deal of the evidence given before the Committee was connected with the electric lighting and electric tramways for towns, etc.

As the inquiry had already been postponed once the Committee felt that any attempt to survey the general subject of municipal trading could only lead to a second postponement. They therefore wisely devoted their attention to the question of auditing municipal accounts.

It appears that under the existing system of making up accounts the auditors are badly paid, or not paid at all. They need have no technical qualifications for the work ; further, strong men, who will take a line of their own irrespective of the wishes of local parties, are never likely to be appointed in some municipalities. Another objection to the present method is that it appears to be practically confined to *mere certification* of figures and to the noting of illegal items of expenditure. The recommendation of the Committee is very sweeping, being nothing less than to entirely abolish the existing systems of audit. They advise that in future the auditor shall be a member of one of the two recognised societies of accountants and auditors, and that he shall hold office for a term not exceeding five years, and be eligible for re-appointment ; also, that he shall not be dismissed by the local authority without the sanction of the Local Government Board. Besides certifying that the accounts are in order or otherwise, and that the accounts present a true and correct view of the transactions and results of trading, etc., it is suggested that the auditor should be required to express an opinion upon the necessity of reserve funds, of amounts set aside to meet depreciation and obsolescence of plant, in addition to the statutory sinking funds, and of the adequacy of such amounts. He is also to report to the Board any case where a local authority declines to carry out his recommendations.

There can be no doubt that the community generally is beginning to be more awake to the true state of affairs, and already municipal borrowers are finding it difficult to float their loans.

Cost of Street Widenings, etc., for Tramways.

Whatever view may be taken as to the proper limits which should be set to municipal trading, it is clearly important that ratepayers should be not less fully and continuously informed of the success or failure of each undertaking than if they were shareholders in an ordinary trading company.

Amongst other points brought out in the evidence was the fact that it is common practice to leave out of municipal electric tramway accounts the cost of any street widenings, etc., which are necessary when the tram lines are laid. The Town Clerk of Leeds actually stated that although he agreed that certain street improvements should be charged to the tramways this cannot be done save by *special power*. The writer would point out that a company, before it can commence operations may have to buy a considerable amount of property to get the necessary street width, and further, in order to keep local authorities from opposing the Bill, the promoters generally have to agree to do a considerable amount of paving or make other road improvements. If a company's accounts have to carry all such expenses, why should a municipal tramway undertaking be exempt ?

There can be no doubt that in many cases where contributions have been made to the rates a proper system of keeping accounts as suggested by the Committee would have shown a loss.

The Sheffield *Municipal* Manufacturing Company.

At the conclusion of their report the Committee recommend that the investigation should be continued

and if this is done some rather startling facts are likely to come to light.

Some time ago the writer paid a visit to the repair shop connected with the electrical department of the Sheffield Corporation and seeing dynamo brushholders of a particular pattern being made in large quantities naturally asked why so many were required. The reply was that they were part of a standing contract with a dynamo manufacturer who shall be nameless, but whose works are over one hundred miles from Sheffield. The artless way in which the explanation was made gave the writer the impression that other fittings, etc., were being carried out in the same way.

Not content with this, the same corporation went into the wiring contracting business, and are known to have carried out work at 50 per cent. under actual cost, and they actually underbid one contractor for a wiring job in a town *[illegible] miles* from Sheffield.

The corporation have sought to legalise their position by a Bill, but when it came before the Committee of the House of Commons they discreetly agreed to a compromise, and so prevented a number of facts, such as the above, from coming to light. The petitioners against the Bill represented electric contracting firms who were assessed at over £2,000 on the Sheffield rates, and in their petition they pointed out the gross injustice of municipal competition supported by the rates, to which they contributed. It was, indeed, a particularly hard case, because the corporation officials had placed obstacles in the way of passing and connecting up installations by some of the petitioning firms, and had further threatened intending customers with delay unless their order was given to the corporation. That such a state of affairs could exist in an important centre of trade like Sheffield shows the length to which municipal trading would go if it is not checked. England has been built up by *individual enterprise*, and can only keep to the front by that.

The Amortisseur Coils.

It is becoming more evident every day that one of the most important improvements in recent dynamo electric machine design is the Leblanc Amortisseur or damping coils. The forms which this idea takes are very diverse, and one particular firm will employ several different methods. The idea is particularly valuable for alternators driven by *single crank* slow running steam engines, and also for gas engines, because the Amortisseur coils help very materially to steady the rotation. In fact, an alternator having its poles surrounded by short circuited copper bars is practically the same as a polyphase motor having a short circuited rotor, and under certain conditions the field magnet system of such an alternator will continue to revolve as a rotor, although the turning effort from the engine may have temporarily failed.

The action may be explained by the fact that the armature current sets up magnetic poles over the alternator core surface, and any change in the relative position of these armature poles and the field poles causes the damping coils to be cut by the shifting armature magnetism, and currents result which *oppose* this shifting of magnetism. In other words the tendency is to steady the rotation, and it will easily be seen how valuable the idea is for running alternators in parallel. It may be interesting to mention that before Leblanc's invention was made known the electrical staff of Messrs. J. Fowler and Co., of Leeds, had noticed that the parallel running of alternators having laminated poles was improved by having gun metal castings between the pole tips and round the ends, these castings being originally put on with the idea of keeping the field coils in place.

For rotary convertors the Amortisseur coil is invaluable, as it tends to prevent the surging or hunting which, once it is set up, may keep on until the whole of the system has to be closed down merely to stop it. A large and important traction system having rotary converters, is said to have once kept it up for two days, every machine on the system hunting in unison.

Proposed Central Engineering Building.

In the last number of the "Journal of the Institute of Electrical Engineers" there is a copy of the resolution carried at the special general meeting by which the institution acquires certain property in Tothill Street for £16,500. This property is in part freehold, and in part leasehold for over 900 years. Many members of the institution have criticised this transaction very severely, because there is a proposal to have some central building which shall house several of the leading engineering societies. Such a joint scheme, if it could be carried out, would be a great advantage in every way, and now is the time for discussing the matter, for the Civil Engineers will sooner or later have to move to make room for Government offices, and the Institution of Mining Engineers will most probably come to London, and several of the other societies are on the look out for a permanent home. A large central building such as is proposed would give the engineering profession improved standing and influence, and would further social and commercial intercourse between the various branches of the profession.

There would be considerable economy in increasing the load factor of the buildings and in reducing establishment charges, whilst by combining the various libraries of the societies, what are now of not much account could be combined to form the nucleus of a library even more complete than that of the Patent Office.

In such an important matter as this the country members are entitled to be heard, and the writer's feeling is that they would generally favour a central building. Such a building is, in fact, at this very moment being proposed for Manchester. If the matter stands where it is there will not be much harm done, as the Tothill Street property has presumably been acquired at fair market value, and can be sold again without loss, and possibly at a profit.

There is one view of the matter which possibly may not appeal to some members, but which is nevertheless worth considering—it is the opinion of the man in the street. If there were to be an imposing building on an important site such as the building of the Royal College of Surgeons or the building to be erected on the Aquarium site, our friend the man in the street would be considerably impressed, and it is well that he should be, for his present idea of an engineer is the driver of a locomotive. The turncock with his highly polished irons is his idea of a civil engineer, and as for the electrical engineer, nearly everyone who commits a petty felony gives electrical engineering as his profession.

Overhead High Tension Transmission Lines.

Long distance transmission is growing [illegible] every day opens up difficulties which as often as they show themselves are promptly surmounted. In the *Electric Review of New York*, Mr. Alton D. Adams

has given some particulars of transmission lines in the States from which the writer has compiled the following table :—

	Distance of transmission.	Voltage.	Number of Pole Lines.	Size of Wire in circular Millimetres.	Material of Wire.	Distance apart of Poles.	Material of Poles.	Length of Pole.
	Miles.					Feet.		Feet.
Niagara and Buffalo ..	25	22,000	Two	12'350,000 6 300,000	Copper Aluminium	75 112	—	—
Canon Ferry and Butte ..	65	50,000	Two	3'106,500	Copper	110	Cedar	35 to 90
Rochester and Pelham .	80	13,200	One	—	Copper	100	Chestnut	35
Electra and San Francisco	90	60,000	Two	3'471,034	Aluminium	—	Squared Redwood	—
Colgate and Oakland ..	142	40,000	Two	3'133,225 3'211,600	Copper Aluminium	132	—	25 to 60

Aluminium is much used, and being only half the weight of copper for equal conductivity, the span between the poles may be greater. It has been as much as 150 ft., and on the Niagara to Buffalo line, as will be seen from the table, the space for copper wire is 75 ft., whilst for aluminium it is 112 ft.

In most cases two independent pole lines are employed with one or more circuits on each. The lines are usually run together, but on the Welland Canal system the two lines are respectively thirty-five miles and thirty-seven miles long, and are located several miles apart. Having two separate lines prevents an arc started on one circuit communicating with the other, whilst there is greater ease and safety in making repairs.

On the Colgate and Oakland line, which is 142 miles long, a body of water 3,200 ft. wide had to be crossed, and in order to allow ships with the tallest masts to pass under it was necessary that the lowest part of the wire should be at least 200 ft. above water level. Two steel towers have been built 4,427 ft. apart, and between these four cables are suspended, each having nineteen strands of galvanised steel wire and measuring $\frac{7}{8}$ in. in diameter. The breaking strain of each cable is forty-four tons, and the electrical conductivity is equal to a No. 2 gauge copper wire. The cables pass over steel rollers on the towers, each cable being secured by a series of strain insulators, the pull equal to twelve tons being taken by an anchor.

Insulated High Tension Cables.

Between Portsmouth and Dover, in New Hampshire, three-phase current at 13,500 volts is carried under the sea for a distance of 4,811 ft. by means of a specially manufactured submarine cable.

The highest voltage used in an insulated cable is 25,000 volts, at the end of the Apple River and St. Paul transmission, in this case the distance being three miles. The highest voltage for an overhead line is 120,000, but it was only temporary for the purpose of a lecture demonstration. At the lower pressures of 11,000 volts there is sixteen miles of cable at Minneapolis, forty-eight miles at Buffalo, and some miles on the Manhattan Elevated Railway, New York.

Coming to this side there are the original paper insulated cables from Deptford to Blackfriars at 11,000 volts, whilst the Metropolitan Electric Supply Company has about forty miles of underground cable at 10,000 volts. The Northern Electric Supply Company employ 10,000 volts, whilst the District Railway and the Metropolitan Railway have placed orders for sixty-seven miles and forty-five miles of insulated cable respectively at 11,000 volts.

It is interesting to note that the Board of Trade are now much more reasonable regarding the employment of overhead high-tension transmission, and the Gloucester Electric Power Company, amongst others, has secured permission to run bare overhead lines at 6,000 volts. This is as it should be, for it now gives the power companies some chance of competing successfully.

The cable manufacturing companies naturally do not much relish this reasonableness of the Board of Trade, as very few of them draw their own copper wire, and there is not much profit on bare copper anyway. The cable makers will no doubt extend their policy of becoming financially interested in the power companies, so as to have underground cables adopted. It is to be hoped however, that the latter will resist this move, as the great expense of underground cables is already a very heavy drag on more than one company.

Poles, Cross Arms, and Insulator Pins.

Wooden poles are used almost exclusively for overhead transmission lines. The kind of wood depends on the country or district, but fir, spruce and pine are commonly employed, whilst in the States harder woods, such as chestnut, cedar, and sawed redwood are also used. In favourable soils spruce and pine will last five years, chestnut twelve, and cedar twenty years, the butts of the poles being, of course, treated with some preservative, such as hot tar, pitch, asphalte, carbolineum, salt (in Salt Lake City), or jodelite.

The last-named material is particularly valuable for transmission lines in tropical countries, where the wood is liable to be attacked by white ants or other insects. As a further protection against atmospheric influences, some of the American pole lines are painted throughout.

Whereas cross arms are usually made of oak in this country, they are generally of yellow pine, treated with asphaltum or linseed oil, in the States. A notch is cut in the pole to receive the cross arm, and it is held by one $\frac{3}{4}$ or $\frac{7}{8}$ in. bolt. If longer than 5 ft. they should be secured by braces. On the Canon Ferry and Butte line (50,000 volts) for example, each brace is 3 ft. long, 3 in. wide, of maple wood fastened with wooden pegs. It is quite impossible to use any metal work at such high voltages.

In extra high tension work experience has shown that wood is the only suitable material for insulator pins. Oak, locust wood, or eucalyptus is employed, the pine, after drying, being boiled for several hours in linseed oil or paraffin. On the Canon Ferry and Butte line the pins are of seasoned oak boiled in paraffin, and they measure $17\frac{1}{2}$ in. long by $2\frac{1}{4}$ in. in diameter in the middle. The insulators are supported high enough to give 9 in. between the lower outside edges of the insulator and the top of the cross arm.

AMERICAN RÉSUMÉ.

NEW YORK, September 20th, 1903.

The American Institute of Electrical Engineers' Convention.

The recent Convention of the American Institute of Electrical Engineers, at Niagara Falls, was in many respects one of the most successful that has ever been held. The attendance was the largest in history, and the papers were exceedingly meritorious. The one objection was that their number was almost too great to allow them all the consideration they deserved. However, the programme was very skilfully arranged, so that all the papers of one class were presented together and discussed at one session.

A very interesting paper, presented by Mr. Paul M. Lincoln, dealt with the choice of frequencies for long distance transmission. Facts and figures were given, all of which pointed to the conclusion that the greatest number of advantages accrue from the use of low frequencies. In a general way this has been realised for some time, but it has never been so forcibly demonstrated by data before. By numerical examples it was shown that the amount of power that can be transmitted over a three-phase line is about two and a half times as great with twenty-five cycles as with sixty, for the same degree of voltage regulation. *Apropos* of the capacity effect of the lines, he stated that if such a line was supplied at sixty cycles, the generators would have to run at practically full load current all the time, irrespective of the actual load, on account of the charging current required by the line. Of course, capacity effect, like inductance, may be decreased by placing the wires closer together, but a certain minimum distance is required to prevent disaster from leakage and brush-discharges. Mr. Lincoln's figures were founded on this basis, and indicate that the only practical way to still further reduce the capacity is to lower the frequency. So far as the generator and line are concerned, as low as ten periods per second are quite allowable, frequency changers being installed where desired; but, all things considered, thirty cycles are to be regarded as the best frequency for present practice, except on short lines, where forty appear to be better.

New Cross-Continent Record.

The Atchison, Topeka, and Santa Fé Railroad has issued a statement concerning the new record for fast time between Chicago and the Pacific Coast established a few weeks ago by the "Lowe Special," so called because it was run on account of Mr. Henry P. Lowe, chief engineer of the United States Steel Corporation. On Tuesday, August 4th, he was apprised of the fatal illness of his daughter in Los Angeles, California, and left New York that day at 2.45 p.m., on the "Twentieth Century, Limited," of the New York Central Railroad, for Chicago. *En route* arrangements were made by wire for a special train over the Santa Fé, which was waiting for him when he arrived at Chicago at 9.54 a.m., August 5th. The transfer by cab required 23 minutes. From Chicago to Los Angeles the special, consisting of a hotel car, baggage car, and an engine, was given right of way, stopping only for water, coal, changing engines or crews, and covered the distance, 2,267 miles, in 52 hours and 45 minutes actual running time. It arrived at 1.06 p.m., 9 hours and 24 minutes ahead of time, which was 15 hours and 16 minutes better than the regular time of the "California Limited," of the Santa Fé, having made an average of 42·8 miles an hour. The total actual time from New York to Los Angeles, 3,246·6 miles, was 73 hours and 21 minutes, or an average speed, including all stops, changes, etc., of 44·1 miles per hour.

The former record between the Pacific Coast and Chicago was made by the "Peacock Special," in 1900, by an average speed of 38·55 miles an hour, actual time.

New Electric Saw Mill.

An extensive plant, including several buildings and a lumber dock, has been erected at St. John's, Oregon, by the Central Lumber Company, for use in connection with a new electric sawmill. The interesting feature of the equipment is the large machine upon which the sawing is accomplished. This consists of four saws, the largest one being driven perpendicularly by a 75-h.p. motor, and the other three horizontally by a 45-h.p. motor. All the saws and the motors are suspended on a steel frame, which moves backward and forward, while the log remains stationary. To bring the logs from the river a ball-bearing truck, operated by a 20-h.p. motor, and running on an incline, is used. Recently, in testing the machine, about 15,000 ft. of lumber was sawn up, and, although the work was not executed quite as rapidly as was expected, it was nevertheless done in a most satisfactory manner. A high class of lumber was used, and it was cut very smoothly, there being none of the roughness noticeable in freshly sawn wood coming from the ordinary mill. It is believed that a greater speed will be acquired after the machine has been in operation longer. An attractive characteristic of the mill is that logs of almost any size may be handled, and there is very little waste. For instance, an immense log 7 ft. thick, which had proved too much for the larger ordinary sawmills, was cut with ease by this machine, and produced all told about 1,700 ft. of board.

Power Plant for the New York Subway.

The power plant for the new rapid transit system of New York City, is likely to be one of the largest electric generating plants in the world. Ultimately it will have a capacity of about 132,000 h.p., and will be supplied with steam by seventy-two boilers of 500 h.p. each. The aggregate capacity of the coal bunkers will be 25,000 tons, and a complete mechanical equipment will be installed for elevating the coal, feeding it to the furnaces by automatic stokers, and

removing the ashes to the dumping scows. Five brick stacks will serve the boilers, each 265 ft. high, with its base resting on a steel platform 40 ft. above the ground level. The building will cover a ground area of 700 ft. by 200 ft., and will be constructed of cut granite, terra cotta and brick, and the roof of tile and glass. Of late, the work has been considerably delayed by labour troubles, but it is expected that the plant will be completed shortly after January 1st, 1904.

To begin with, nine mammoth engines will be installed, each capable of developing 11,000 h.p. when driven to its utmost. These will be of the horizontal-vertical compound type, the horizontal cylinder taking high-pressure steam superheated to about 500 deg. Fahr., and exhausting into a receiver, from which the vertical low-pressure cylinder will draw its supply. Each unit will be practically double, the generator being located between two compound engines. The cranks will be set at 135 deg. with each other; the two connecting rods of each engine acting on the same crank pin. By this arrangement, eight impulses will be given to the shaft per revolution, which will provide a uniform turning effort, and the close regulation so essential where alternating current generators are to be run in parallel.

The high-pressure cylinders will be 42 in. in diameter, and the low-pressure 60 in., so that the ratio of cylinder volumes will be 4·4. An initial steam pressure of 175 lb. to 200 lb. will be used, and the final exhaust will be into a vacuum of 26 in., maintained by barometric condensers. The speed will be 275 revolutions per minute, and at normal rating each engine will develop 7,500 h.p.

The unique feature of the engines will be the use of a poppet-type of valve for both admission and exhaust on the high-pressure cylinders, for the purpose of preventing the cutting of the valves that usually accompanies the use of superheated steam. The valves will be located at the top of the cylinders, and will be actuated by rods from wrist-plates, so that they will have the quick opening and closing characteristics of the Corliss gear.

To gain some conception of the massiveness of these machines, which were designed and are being built by the Allis-Chalmers Company, of Milwaukee, Wisconsin, it is interesting to note that the crank pins will be 20 in. in diameter, by 18 in. long; cross-head pins, 13 in. in diameter, by 13 in. long; main journals, 34 in. in diameter, by 60 in. long; high-pressure rods, 9 in. in diameter; low-pressure rods, 10 in. in diameter, and the main shaft will be 37 in. in diameter, and of oil-tempered steel, with a 16-in. hole bored through its centre from end to end. The total weight of the engine, exclusive of the generator, will be 1,240,000 lb.

A Load Equalizer for Three-Wire Systems.

A patent, granted to Mr. Norman Rowe, of Wilkinsburg, Pa., provides for an interesting system of electrical distribution whereby a local balanced three-wire system may be obtained from a distributing system of the common two-wire form. The scheme makes use of two compound-wound motors mounted on the same shaft with the armatures and series field coils of each connected in series across the two-wire mains and the shunt field coils similarly connected together across the mains. The third or neutral wire is led from a point between the two motors where the end of the armature winding of one and the end of the series field coil of the other unite. When the loads on the two sides are equal the two motors run as differential motors and are available for power purposes. When the load of one side exceeds that of the other the corresponding motor becomes a generator driven by the other motor, through the fact that the series field is wound so as to produce over-compounding. For the same reason the motor on the lighter loaded side picks up in speed. By properly proportioning the turns in the series coils a nearly perfect balancing of the voltage in the two sides is accomplished. According to the inventor the amount of unbalancing which may be handled through the use of this arrangement is measured by the combined rating of the two machines less the power utilised from either or both as motors in the driving of outside machinery. It is also claimed that practically equal voltages will be maintained in both sides, without the necessity of any adjustment, between no load and fifty per cent. overload.

New Railroad Shops.

The Southern Pacific Railroad Company is building new shops at East Los Angeles, California, the estimated cost of which will be $400,000. They include a boiler and blacksmith shop, machine and erecting shop, car repair shop, car paint shop, transfer table, and boiler material building. Electric motors will be used for the drive of most of the machinery in the plant; individual direct-connection being used in many instances, and group drive by belting from motor-driven shafting in other cases. One of the most noteworthy parts of the complete plant will be the turn-table, which will be located in the round house. It will be 70 ft. in diameter, and will be operated electrically.

Electric Towing Locomotives.

The Miami and Erie Transportation Company, with a view to conducting a freight-carrying trade on a paying scale over the Ohio State Canals, has provided electric towing locomotives for use between Cincinnati, Lockland, and Hamilton. An endeavour will be made to adopt methods that shall stimulate those employed by the railroads, in the hope of establishing a more remunerative business than has heretofore been possible. The tows will consist of three barges each, and will make regular trips daily in accordance with a specified time-table. The towing cars will be driven by alternating current motors, and to avoid injurious washing of the banks of the canals, the maximum speed will be limited to four miles per hour. The Cincinnati and Toledo Packet Company will also make an attempt to increase the traffic over these canals by using gasoline and steam launches for towing purposes.

GERMAN RÉSUMÉ.

BERLIN, September 20th, 1903.

New Electric Traction Experiments on Prussian Railways.

In the experiments which have just been commenced on the Spindlersfelde line in the environs of Berlin, it is not intended to attain high speeds, but rather to demonstrate the practicability of single-phase alternating current as applied to the new motor designed by the Union Elektricitäts-Gesellschaft. This company, it will be remembered, supplied part of the electrical apparatus for the London "Twopenny Tube," in conjunction with the British Thomson-Houston Company, and has made a speciality of electric traction. The Union Elektricitäts-Gesellschaft and the Allgemeine Elektricitäts-Gesellschaft, as is well known, have recently combined, forming the largest concern in the field of electric industry.

That there is no difficulty whatever in the operation of interurban or suburban lines by electricity has been proved sufficiently in England and America, as well as lately on the Lichterfelde line of the Prussian railway, which has also been equipped by the Union Elektricitäts-Gesellschaft (see our summary of last month). But, when a long line of, say, 100 to 300 miles is to be operated by electricity, the present methods, though successful with short lines, become too expensive. The comparatively low-pressure continuous current has to be generated in a number of sub-stations distributed along the line, these sub-stations being fed from one or more central stations furnishing high-pressure. Such sub-stations for the production of continuous current from alternating current require rotating machines and a good deal of first cost and expensive maintenance and care. Now, such sub-stations containing machinery may be replaced by sub-stations which are very low in first cost and maintenance, providing *alternating current* as used on trains. A number of different methods have been suggested for accomplishing this, and one or two roads of more or less promise are being built in different countries. The simplicity of the motor in question, however, seems to put it far ahead of anything else produced up to date, and it seems to have all the best characteristics of the ordinary tramway motor, which has proved so successful all over the world. The great point, however, is its being capable of every desirable degree of speed regulation without requiring expensive, cumbersome, and uneconomical regulating devices. In the present case only one wire is used to transmit the current to the car, and the pressure of 6,000 volts is so high that this wire may be very small. The working current is led directly to the motors without any previous transformation. This system is so simple that it may easily be applied to lines connecting cities two or three hundred miles apart.

This scheme constitutes a splendid solution of the problem of electric railways under existing conditions. Every such new step forces all thoughtful railway managers to consider seriously the advantages of electric traction.

The Berlin Congress for Wireless Telegraphy.

As stated in our last summary, the conclusion was arrived at in the recent Congress for Wireless Telegraphy, to keep the results of the proceedings strictly private for some time, so as to enable the representatives of the various countries in the meantime to present their reports. It, however, appears that the most important result of the Conference consists in the decision that the various Governments should try to arrive at a satisfactory solution of the problem of internationalising wireless telegraphy, and thus rendering obligatory the exchange of telegraphic communication between the stations of the new systems all over the world. This deliberation is immediately directed against the Marconi system. The proposal is said to be actively supported by Russia and Germany, and it is safe to assume that in the case of the Marconi Company proving immovable on this point, a boycott would be started in order to compel Marconi to give up his ideas of monopolising wireless telegraphy. If Marconi continued repelling any attempt of international combination, some Powers would prohibit their vessels from installing on board the Marconi apparatus, and from acknowledging his system.

In connection with the above Conference, we learn, two electric ondographs, constructed by the Wireless Telegraphy Company, were shown. From the point of view of an international wireless telegraphic service, the most important point is the possibility this apparatus is stated to afford of tuning a station of any given system with a station of any other system. The drawback constituted by the individuality of systems will thus be eliminated. An agreeable surprise to the members of the Conference was a new receiving apparatus presented by the inventor, Mr. Schloemisch, of the Wireless Telegraphy Company. This apparatus utilises the influence exerted by electric waves on the decomposition processes of an electrolytic voltameter, a so-called polarisation element. The perfect tuning, as obtained by means of this apparatus, its practical immunity from electric disturbances, its surprising simplicity, and its other technical and electrical properties seem to justify the hopes attached to it.

In a near future there are to be performed long-distance experiments in the field of wireless telegraphy between the Oberschönweide Electric Works, belonging to the Wireless Telegraphy Company, and one of its Swedish sea stations, viz., that of Karlskrona; the system to be used is the Slaby scheme, and it is hoped to transmit despatches over distances as high as 450 kilometres.

Wind-driven Electricity Works.

Although these notes are chiefly concerned with German practice, we may occasionally give an account also of progress made in some of the neighbouring countries. The problem of using wind power

in connection with electricity works has often been investigated, the principal drawback being the variable strength of the wind, resulting in corresponding variation in the speed of the dynamo. This difficulty, however, it appears, has recently been solved by Professor la Cour, who, on behalf of the Danish Government, has for some years past been engaged in studying the question. In order to impart to the motors an approximately continuous speed, independently of the strength of the wind, Professor la Cour uses an intermediate shaft placed in connection with a balance. The belt from the mill is led vertically on the disc of this shaft, its pressure on the latter being regulated by the balance bearing convenient counter-weights. This arrangement results in the belt sliding on the disc as soon as the load exceeds a given maximum. A plant of this kind, feeding about 450 glow-lamps, has for nearly a year been in operation at Askov, Denmark, petroleum motors serving as a reserve in cases of several days calm weather.

The constant normal current with these works is 50 amperes, and their distribution tension 2 volts by 110 volts. This plant has so far worked with satisfactory results, and required no supervision worth speaking of. As regards the economical side of the question, a similar plant has been found to pay very well. The first cost has been calculated at 16,000 kr., out of which 3,000 kr. correspond to the petroleum motor. The current is supplied to consumers at the same price as in Copenhagen, *i.e.*, at the rate of 50 öre per kilowatt-hour for lighting, and 15 öre per kilowatt-hour for power purposes. The receipts for energy sold have been about 2,800 kr., and the expenses about 800 kr. per year. There will thus remain 2,000 kr. for the amortisation of this plant, a sum more than sufficient for a capital of 16,000 kr. The price of the energy could therefore be further diminished. In the case of very small electricity works intended for the use of a limited number of houses, the petroleum motor may advantageously be replaced by a horse-driven contrivance. Moreover, in the case of the proprietor of the works being his own consumer, the consumption of current way be regulated according to the actual supply of wind, the cost of the plant thus being further lowered.

A solution of the problem at issue will doubtless lead towards rendering electricity accessible at relatively low cost, even in small communities, and more especially in rural districts.

The Premium System of Remunerating Labour.

The premium system of remunerating labour is now receiving attention also in Germany. In a paper recently published in the *Zeitschrift des Vereines Deutscher Ingenieure*, B. Schiller gives a critical survey of the advantages and drawbacks of the different modifications of the original Halsey system. It is pointed out that both with the Halsey and Rowan systems, the cost of manufacture at equality of time is the lower, as the rate of wages is lower. This injustice with respect to the workmen is avoided in a modification of the original system, as proposed by the author. In this system the premium depends on the time saved, and the following conditions are satisfied : first, the workmen should obtain the same profit under otherwise equal conditions ; and, second, the cost of manufacture should remain the same. It is shown that when using this system the time required to obtain equal costs per piece is the shorter as the rate of wages is higher. With different rates and equal times of manufacture, the profits per hour are really the same ; the lower the rate of wages, the lower will be the cost per piece at equality of time required to finish the work. The author finally draws attention to the fact that all these premium systems so far as records are forthcoming, have given every satisfaction. The system to be chosen in each special case, should, in the author's opinion, form the subject of a thorough consideration of the actual conditions.

A Steam Tug with Superheated Steam.

The *Mannheim Dampfschleppschiffahrt Gesellschaft* recently launched the first Rhine tug to be operated with superheated steam. After some unlucky attempts to use superheat on the Rhine steamers, made as far back as 1860, the above company was induced by the success obtained in this line by the steamships plying the Italian and Swiss lakes, to use superheat with two steam tugs ordered from Messrs. Escher, Wyss and Co., Zurich, out of which one has just been completed.

The dimensions of the *Johann Kessler* are as follow : Length between the leads, 70 om. ; breadth between the wheel-cases, 8·5 om. ; height, 3·1 om. ; draught, about 1·0 om. ; The engine is a 800 h.p. to 1,000 h.p. three-cylinder wheel engine, the dimensions of the cylinders being as follow : Diameter of high-pressure cylinder, 550 millimetres ; diameter of medium pressure cylinder, 800 millimetres ; diameter of low-pressure cylinder, 1,300 millimetres ; stroke, 1,650 millimetres.

There are two pairs of boilers, designed for thirteen atmospheres super-pressure, being arranged before and behind the engine respectively. The superheaters are built into a special flame pipe ; they are made up of a number of U-shaped pipes, arranged in circles. After entering one of the annular spaces of the distribution chamber, the steam will pass through the U-pipe, and, in the superheated state, will reach the second annular space, and hence the engine. The fire-gases surrounding the superheater tube will issue from the superheater chamber through openings liable to be shut by means of a sliding regulator, enabling the degree of superheat to be regulated, and rendering it possible for the superheater to be disconnected.

With the first run of the *Johann Kessler*, 2,500 tons were hauled from Duisburg to Mannheim, when both the super-heater and the engine worked with most satisfactory results, and the temperature of the steam in the slide-box of the high-pressure cylinder was 290 deg., *i.e.*, about 95 deg. above the temperature of saturated boiler steam at 13 atmospheres.

SOUTH AFRICAN RÉSUMÉ.

JOHANNESBURG, Sept. 20th, 1903.

Experiments with a Safety Clutch.

The thorough manner in which new and promising inventions are tested on the Witwatersrand goldfields when they reach the practical stage is illustrated by some experiments recently made at the Rose Deep Mine on a new safety clutch for cages, devised by Mr. R. Hainsworth.

The experiments were carried out under the supervision of Mr. Laurie Hamilton, manager of the Rose Deep, Mr. Webber, general manager of the Rand Mines, and Mr. Robeson, consulting mechanical engineer of the same group.

The bridle of the skip consists of the long arms of two levers, which are pivoted to the skip frame about 6 in. from the guides. The short ends of these levers, when released, actuate a set of dogs on each side of the cage which bite into the wooden guides, and so prevent it from falling. The long arms of the levers are provided with springs which tend to pull them down, and thus bring the dogs into action. The hauling rope is attached to a shackle connecting the ends of these arms, so that the clutch cannot act while the weight of the cage is supported by the rope.

After a first test with the empty cage it was loaded to a total weight of about 3½ tons, raised in the head gear, and suddenly detached from the rope by means of a slip hook. The cage only fell one inch before the dogs acted and held. The same test repeated after guides and dogs had been well greased gave also a satisfactory result, with a fall of 7½in. before the cage was stopped.

Having thus proved the efficiency of the apparatus in cases where the cage becomes disconnected from the hauling rope, or when the latter breaks near the bridle, a final crucial experiment was made to ascertain the effect of a breakage occurring in the rope a long way above the cage.

For this purpose the inside end of the hauling rope (650 ft. long) was disconnected from the drum of the winding engine, and the cage was lowered by the engine at about 200 ft. per minute. It appeared from subsequent examination of the guides that when the free end of the rope ran off the drum (the cage being then down 475 ft.), the dogs engaged the guides for a depth of about 60 ft. without, however, actually stopping the fall. The fouling of the loose end of the rope with the headgear then apparently withdrew the clutch during a further fall of 70 ft., after which it again came into action, but too late to arrest the cage before it reached the bottom of the shaft, where it was consequently smashed. It is perhaps needless to say that an old cage was used for these experiments. The result shows that safety clutches which are held off by the tension of the hauling rope cannot be relied upon in all cases of accident.

New Road Bridges.

The Transvaal Government has put forward an extensive programme of bridge construction on the main roads of the Colony. It embraces sixty-seven structures of spans varying from 30 ft. to 100 ft., at a total estimated cost of £177,677, of which £60,000 is to be expended this year on seven of the most important bridges already determined, and upon others to be selected later. Standard designs have been prepared for the different spans and tenders invited for their delivery F.O.B., English ports.

Quarterly Output.

The following figures are taken from the official returns of the Government Mines Department :—

	Gold.	Silver.	Coal.	Diamonds.	
1903.	Fine ounces.	Fine ounces.	Tons sold.	Carats.	Value £
April ..	226,793,033	25,673,506	17,173,840	1,695	2,172
May ..	234,351,681	28,750,003	19,170,074	11,523	14,743
June ..	237,460,160	28,694,817	19,191,625	15,425	21,818

The following table from the same source shows the gradual increase in the labour employed by the mines :—

	Gold Mines.		All Mines.	
	White.	Coloured.	White.	Coloured.
April	11,305	55,340	11,893	63,370
May	11,439	57,898	12,096	66,374
June	11,790	59,345	12,460	67,899

The average number of rock drills now at work is 1,340.

River Diamonds.

The old river diggings on the Vaal near Kimberley, although they have been worked for so many years, still occasionally give good stones. During the present month stones of 43 and 88 carats respectively have been found, as well as one worth £350, but as a rule these diggings only provide an uncertain and not too generous livelihood for the workers.

Possibly Tin.

The discovery of tin in payable quantities near Inchanga is reported from Durban, but, of course, all such reports require confirmation, as prospectors are invariably sanguine.

A Rich Patch.

One of the very rich pockets which occasionally occur in quartz reefs has been found in Rhodesia. One half ton of rock is said to have yielded 450 ounces of nuggety gold, the heaviest pieces weighing 20 oz. It is such finds as this which constitute at once the charm and the snare of gold mining on quartz reefs.

The Mechanical Engineers' Association of the Witwatersrand.

A portrait of Major Seymour, the first president of the Mechanical Engineers' Association of the Witwatersrand, has just been unveiled, and for the present hangs in the Council Room of the Chamber of Mines, where the Association holds its meetings. The portrait is a half-length one and represents the late major in khaki. It was executed by Professor Herkomer, and is described as an excellent likeness.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

BRITISH RAILWAY ENTERPRISE.

IN the course of his presidential address to the Engineering Section of the British Association, Mr. Charles Hawksley touched upon a wide range of subjects, and, discussing railways, remarked that on some of the principal lines in Great Britain, the length of the runs without a stop was being increased in the case of fast trains, the speed of which was in some cases from 48 to 59 miles an hour. Railway companies were turning their attention to the introduction of electric traction wherever it could be beneficially used, as, for instance, on the Mersey Railway, the North-Eastern Railway between Newcastle-upon-Tyne and Tynemouth, and the Lancashire and Yorkshire Railway between Liverpool and Southport. With the object of facilitating the introduction and use of electrical power on railways, Parliament had passed an Act entitled the "Railways (Electrical Power) Act, 1903," which would come into operation on January 1st next.

THE MERSEY RAILWAY.

The electrical service on the Mersey Railway had now been in regular and uninterrupted operation since the beginning of May in the present year. Trains were run at three-minute intervals, there being 750 trains in all between 5 a.m. and 12 midnight. It was the first example of a British steam railway converted to the use of electric traction, and was first opened for traffic on February 1st, 1886. It was afterwards extended at both ends, the last extension to the Liverpool Central Station being opened for traffic in January, 1892. With steam locomotives, largely owing to the want of adequate ventilation, the railway was not a success. Electrification was decided upon, and in the latter part of 1901 the British Westinghouse Electric and Manufacturing Company, Ltd., undertook the entire contract. The length of the railway was now about 3¾ miles, and there were gradients in the tunnel below the river of one in 27 and one in 30. The power station was at Birkenhead, and contained plant aggregating over 6,000 h.p., comprising three engines of the Westinghouse-Corliss vertical cross-compound type. The generators were all three alike, mounted on the engine shaft between the cylinders. They were standard Westinghouse multi-polar machines of the double-current type, of 1,250 kilowatts capacity, Direct current was collected from the armature at 650 volts, no alternating current being used at present. Leads were carried below the floor from the machines to a switchboard, from which were controlled the main generators, the auxiliary lighting sets, battery, booster, and feeders. The battery consisted of 320 chloride cells connected in parallel with the generators through a differential booster, and which charged or discharged as the line load was light or heavy. They had a capacity of 1,000 ampere-hours, and a mometary discharge capacity of 2,000 amperes. The auxiliary sets, two in number, were for lighting purposes, and yielded direct current at 650 volts. They were available in case of need to supply current to the main traction circuits. Two hundred and ten volt incandescent lamps were used for lighting. The feeders were carried from the switchboard down the ventilation shaft to feed the insulated electrical collector rails, which were placed in the space between the up and the down lines, and somewhat above the level of the rails, an insulated return collector rail being placed between each pair of rails. A train consisted of two motor-cars, one at each end, and from one to three trailers as required, depending on the amount of traffic. The motor-cars each carried an equipment of four Westinghouse motors of 100 h.p., making 400 h.p. per car, or 800 h.p. per train. These motors were all controlled in unison from the motorman's compartment, at either end of the train by means of the Westinghouse multiple controlled system, which was worked from the start without a hitch. Every precaution had been taken against fire. The electrical equipment was all thoroughly fireproof, and the motorman's compartment was encased in asbestos slate, cutting it off completely from the remainder of the train.

"TUBES."

Of tube railways with electric traction there were three now working in London, two between the City and the south side of the River Thames, using the ordinary two-wire 500-volts continuous current system, and another (the Central London), extending from the City to Shepherd's Bush, using the composite system. The railway conveyed during the year 1902 no fewer than 45 million passengers. There were eight other tube railways now in course of construction in London. The recent terrible catastrophe in Paris should serve as a warning in the equipment of lines where currents at high tension were employed, and where short-circuiting might bring about disastrous results.

BRITISH MINERALS.

THE FUTURE DEVELOPMENT OF OUR COALFIELDS.

IN the course of a presidential address to the Geological Section of the British Association, Professor W. W. Watts made some important remarks on the relation of geological knowledge to all economic questions connected with the mineral wealth of the Empire; more particularly our coal fields.

The knowledge of our mineral resources was of vita consequence to ourselves and to our present and future welfare as a nation, and yet it was a matter of much popular misconception. It had been the good fortune of this country to be the first to realise, and with characteristic energy, to take advantage of, the new possibilities for development opened up by the discovery and utilisation of its mineral wealth. We were

exceedingly fortunate in having so much of this wealth at hand, easy to get and work from geological considerations, cheap to transport and export from geographial considerations. So we were able to pay cash for the products of the whole world, to handle, manufacture, and transport them, and thus to become the traders and carriers of the world. But other nations were waking up. We had no monopoly of underground wealth, and day by day we were feeling the competition of their awakening strength. Could we carry on the struggle and maintain the lead we had gained ?

THREE GREAT CONSIDERATIONS.

In answering this question there were three great considerations to keep in mind. First, our own mineral wealth was unexhausted ; secondly, that of our Colonies was as yet almost untouched ; and, thirdly, there were still many uncolonised areas left in the world. The very plenty of our coal and iron and the ease of extracting it had been an economic danger. There had been waste in exploration because of ignorance of the structure and position of the coal-yielding rocks ; waste in extraction because of defective appliances, of the working only of the best-paying seams and areas, of the water difficulty, and the want of well-kept plans and records of areas worked and unworked ; waste in employment because of the low efficiency of the machinery which turns this energy into work. With all this waste our coalfields have hardly yielded a miserable 1 per cent. of the energy which the coal actually possesses when *in situ*. Engineers and miners were trying to diminish two of these sources of waste, and geology had done something to reduce that of exploration. This had been done by detailed mapping and study, so that we now knew the areas covered by the coal-seams, their varying thickness, the " wants," folds, and faults by which they were traversed, and all that great group of characters designated as the geological structure of the coalfields. Up to the present it was our visible coalfields that we had been working, and we had got to know their extent and character fairly well. But so much coal had now been raised, so much wasted in extraction, and so many areas rendered dangerous or impossible to work, that we could not shut our eyes to the grave fact that these visible fields were rapidly approaching exhaustion. The Government had done well to take stock again of our coal supply, and to make a really serious attempt by means of a Royal Commission to gauge its extent and duration ; and we all looked forward to that Commission to direct attention to this serious waste and to the possibility of better economy, which would result from the fuller application of scientific method to exploration, working, and employment.

THE AREA OF CONCEALED COALFIELDS.

But we still had an area of concealed coalfields left, possibly at least as large and productive as those already explored and as full of hope for increased industrial development. It was to these we must now turn attention with a view of obtaining from them the *maximum* amount possible of the energy that they contain. The same problems which beset the earlier explorers of the visible coalfields would again be present with us in our new task, and there would be in addition a host of new ones, even more difficult and costly, to solve. In spite of this, the task would have to be undertaken, and we must not rest until we had as good a knowledge of the concealed coalfields as we had of those at the surface. This knowledge would have to be obtained in the old way by geological surveying and mapping and by the co-ordination of all the observations available in the productive rocks themselves and in those associated with them, whether made in the course of geological study or in mining and exploration. But now the work would have to be done at a depth of thousands instead of hundreds of feet, and under a thick cover of newer strata resting unconformably on those we wish to pierce and work. When we got under the unconformable cover we met the same geology and the same laws of stratigraphy and structure as in more superficial deposits, but accurate induction was rendered increasingly difficult by the paucity of exposures and the small number of facts available owing to the great expense of deep boring. How precious, then, became every scrap of information obtained from sinkings and borings, not only where success was met with, but where it was not ; and how little short of criminal was it that there should be the probability that much of this information was being, and would be, irretrievably lost !

NECESSITY FOR GEOLOGICAL SURVEYS AND TEACHING.

Systematic and detailed exploration, guided by scientific principles, and advancing from the known to the unknown, ought to be our next move forward ; a method of exploration which should benefit the nation as well as the individual, a careful record of everything done, a body of men to interpret and map the facts as they were acquired, and draw conclusions with regard to structure and position from them—in short, a geological survey which should do as much for hypogean geology as existing surveys had done for epigean geology was now our crying need. Unless something of this sort was done, and done in a systematic and masterful manner, we ran a great risk of frittering away the most important of our national resources left to us, of destroying confidence, of wasting time and money at a most precious and critical period of our history, and of slipping down hill at a time when our equipment and resources were ready to enable us to stride forward. In many of our colonies much was being done by competent surveys to attain a knowledge of mineral resources, but this work should be pushed forward more rapidly, with greater strength and larger staffs, and, above all, it should not be limited to areas that happen to be of known economic value just at the present moment. It was almost a truism that the scientific principle of to-day was the economic instrument of to-morrow, and it would be a good investment to enlarge the bounds of geological theory, trusting to the inevitable result that every new principle and fact discovered would soon find its economic

application. Further, it was necessary that we should obtain as soon as possible a better knowledge of the mineral resources of the smaller and thinly inhabited colonies, protectorates, and spheres of influence. This was one of the things which would conduce to the more rapid, effective occupation of these areas. With regard to areas not at present British Colonies, no great harm would be done by obtaining, not in any obtrusive way, some general knowledge of the mineral resources of likely areas. This at least was what other nations found it worth their while to do, and then, when the opportunity of selection arises, they were able to choose such regions as would most rapidly fill up and soonest yield a return for the private or public capital invested in them. To sum up, the time had come when geologists should make a firm and consistent stand for the teaching of their science in schools, technical colleges, and Universities.

A PLEA FOR MORE UNIVERSITIES AND A SCIENTIFIC NATIONAL COUNCIL.

SIR NORMAN LOCKYER, K.C.B., LL.D., F.R.S., in the course of his Presidential Address at the seventy-third annual meeting of the British Association, advocated the more complete organisation of men of science, and for more universities to enable the country to play her part efficiently in the struggle of the nations. We are suffering, he said, not because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are apt to be careless in securing them.

In one chemical establishment in Germany 400 doctors of science, the best the universities there can turn out have been employed at different times in late years. In the United States the most successful students in the higher teaching centres are snapped up the moment they have finished their course of training and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must necessarily be young, and that it is the training, and not the age which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge. I should not be doing my duty if I did not point out that the defeat of our industries one after another, concerning which both Lord Rosebery and Mr. Chamberlain express their anxiety, is by no means the only thing we have to consider. The matter is not one which concerns our industrial classes only, for knowledge must be pursued for its own sake; and since the full life of a nation with a constantly increasing complexity, not only of industrial, but of high national aims, depends upon the universal presence of the scientific spirit—in other words, brain-power—our whole national life is involved.

UNIVERSITIES AT HOME AND ABROAD.

So far as our industries are concerned, the cause of our failure has been run to earth; it is fully recognised that it arises from the insufficiency of our universities both in numbers and efficiency. The science which our young men neglect at the universities, with the full approval of their teachers, is now one of the great concerns of the nation. We in Great Britain have thirteen universities competing with 134 State and privately endowed in the United States and twenty-two State-endowed in Germany. The German State gives to one university more than the British Government allows to all the universities and university colleges in England, Ireland, Scotland, and Wales put together. These are the conditions which regulate the production of brain-power in the United States, Germany, and Britain respectively, and the excuse of the Government is that this is a matter for private effort. Do not our Ministers of State know that other civilised countries grant efficient State aid, and, further, that private effort has provided in Great Britain less than 10 per cent. of the sum thus furnished in the United States? When, then, we consider the large endowments of university education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either.

A DRASTIC PROPOSAL.

The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other, or both, of which other nations depend. We are between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present Slough of Despond, must be the giving up of the idea of relying upon private effort.

If we consider the United States and Germany, our chief commercial competitors, and apply the Admiralty principle, with regard to sea power, we should require, allowing for population, eight additional universities at the very lowest estimate. Therefore, if our present university shortage be dealt with on battleship conditions, to correct it we should expend at least £8,000,000 for new construction, and have to provide £400,000 yearly for the *personnel* and up-keep. Let us say, roughly capitalising the yearly payment at 2½ per cent., £24,000,000. Even Oxford, our oldest university, will still continue to be a mere bundle of colleges unless three millions are provided to enable the university, properly so-called, to take her place among her sisters of the modern world; and Sir Oliver Lodge, the principal of our very youngest university, Birmingham, has shown in detail how five millions can be usefully and properly applied in that one locality to utilise for the good of the nation the enthusiasm and scientific capacity which are only awaiting for adequate opportunity of development.

How is this money to be raised? I reply, without

hesitation, duplicate the Navy Bill of 1888-9; do at once for brain power what we so successfully did then for sea power. Let £24,000,000 be set apart from one asset, our national wealth, to increase the other, brain-power. Let it be assigned and borrowed as it is wanted; there will be a capital sum for new buildings to be erected in the next five or ten years, the interest of the remainder to go towards increased annual endowments.

A SCIENTIFIC NATIONAL COUNCIL PROPOSED.

I finally come to the political importance of research. A country's research is as important in the long run as its battleships. The most eloquent teaching as to its national value we owe to Mr. Carnegie, for he has given the sum of £2,000,000 to found a system of endowments, its chief purpose being, in his own words "to secure if possible for the United States of America leadership in the domain of discovery and the utilisation of new forces for the benefit of man." Here is a distinct challenge to Britain.

Judging by experience in this country, in spite of the magnificent endowment of research by Mond and Lord Iveagh, the only source of support in the British interest is the State, which certainly could not put the 1-8000th part of the accumulated wealth of the country to better use; for without such help both our universities and our battleships will become of rapidly dwindling importance. We need a Scientific National Council. In Germany there is such a council. It consists of representatives of the Ministry, the universities, the industries, and agriculture. It is small, consisting of about a dozen members, consultative, and it reports direct to the Emperor. It does for industrial war what military and so-called defence councils do for national armaments. I am informed that what this council advises generally becomes law. A scientific council, which might be a scientific committee of the Privy Council, in dealing primarily with the national needs in times of peace, would be a source of strength to the nation.

THE MIRACLE OF RADIUM.

MR. CHARLES VERNON BOYS, President of the Mathematical and Physical Science Section of the British Association, referred in his address to the intrinsic importance and revolutionary possibilities of radium. The discovery by Professor and Madame Curie of what seems to be the everlasting production of heat in easily measurable quantity, by a minute amount of radium compound, was so amazing that even when we had seen the heated thermometer we were hardly able to believe what we had seen. This discovery, which could barely be distinguished from that of perpetual motion, which it was an axiom of science to call impossible, had left every chemist and physicist in a state of bewilderment. Further, Sir W. Crookes had devised an experiment in which a particle of radium kept a screen bombarded for ever, each collision producing a microscopic flash of light, the dancing and multitude of which forcibly compelled the imagination to follow the reasoning faculties and realise the existence of atomic tumult. Thanks to the industry and genius of a host of physicists at home and abroad, the mystery was being attacked, and theories were being invented to account for the marvellous results of observation. An atom of radium could certainly produce an emanation that was something like a gas, which escaped and carried with it wonderful properties; but the atom, the thing which could not be divided, remained and retained its weight. The emanation was truly wonderful. It was self-luminous, it was condensed by extreme cold and vaporised again; it could be watched as it oozed through stopcocks, or hurried through tubes, but in amount it was so small that it had not yet been weighed. Sir W. Ramsay had treated it with a chemical cruelty that would well nigh have annihilated the most refractory or permanent known element; but this evanescent emanation came out of the ordeal undimmed and undiminished. The radium atom sent out three kinds of rays, one kind being much the same as Röntgen rays, but wholly different in ionising power, according to the experiments of Strutt. Each of these consisted of particles which were shot out, but had different penetrative power; they were differently deflected by magnets and also by electricity, and the quantity of electricity in relation to the weight was different, and yet the atom, the same atom, remained unchanged and unchangeable.

ITS ENDURING QUALITIES.

Not only this, but radium or its emanations or its rays must gradually create other bodies different from radium, and thus, so we were told, one at least of those new gases which but yesterday were discovered had its origin. Then, again, just as these gases had no chemical properties, so the radium which produced them in some respects behaved in a manner contrary to that of all proper chemicals. It did not lose its power of creating heat even at the extreme cold of liquid air, while at the greater degree of cold of liquid hydrogen its activity was found by Professor Dewar to be actually greater. Unlike old-fashioned chemicals, which, when they were formed, had all their properties properly developed, radium and its salts took a month before they acquired their full power (so Dewar told us), and then, for anything we knew to the contrary, proceeded to manufacture heat, emanations, three kinds of rays, electricity, and gases for ever. For ever; well, perhaps not for ever, but for so long a time that the loss of weight in a year (calculated, he supposed, rather than observed) was next to nothing. Professor Rutherford believed that thorium or uranium, which acted in the same kind of way, but with far less vigour, would last a million years before there was nothing left, or at least before they were worn out; while the radium, preferring a short life and a merry one, could not expect to exist for more than a few thousand years. In this time one gramme would evolve one thousand million heat-units, sufficient, if converted into work, to raise 500 tons a mile high; whereas a gramme of hydrogen, our best fuel, burned in oxygen, only yielded 34,000 heat-units, or one thirty-thousandth

part of the output of radium. He believed that this was no exaggeration of what we were told and of what was believed to be experimentally proved with regard to radium; but if the half of it were true, the term "the mystery of radium" was inadequate; the miracle of radium was the only expression that could be employed.

AUXILIARY PUMPING MACHINERY.

At the opening meeting of the new session of the Institute of Marine Engineers, at the Institute premises, 58, Romford Road, Stratford, E., a paper by Mr. S. H. Terry, on "Auxiliary Pumping Machinery, and Suggested Improvements," was read and discussed.

In several wrecks which took place about twenty years ago—he might mention the *Clan Macduff* and the *Bristol City*—it was usually a stock phrase that the crew and passengers worked at the hand-pumps until they dropped exhausted. At that period the centrifugal pump was but little known on board ship, and he had taken some trouble to bring his arguments in favour of the adoption of efficient pumping machinery before the principal shipbuilders and owners, and also before the technical advisers of Lloyd's Register. At the present day it was satisfactory to know that any British vessels of over 1,000 tons—and many of much smaller size—were almost certain to be fitted with centrifugal pumps. It was, however, a matter of regret that too often the suction and discharge pipes and valves of those pumps were too small in diameter, too lengthy, too complicated, and frequently had far too many abrupt turns, angles, bends, and unions for the efficient passing of so weighty a liquid as water at high velocities.

To be really efficient in the event of flooding in the engine-room or compartment in which the centrifugal pump was situated, it was necessary for the pump to be placed sufficiently high to enable it to continue working when the main engines were already drowned out. That, of course, would necessitate the provision of an efficient foot valve, and it was also of great importance that the donkey boiler be so placed that the fire should remain alight after the main boilers were drowned out. So far as steam connections were concerned, they, as engineers, knew how necessary it was to provide dry steam. To the draftsman, however, that matter was of secondary importance, as it sometimes seemed to be to the consulting engineer or naval architect. Some designers apparently seemed to think that steam and water could advantageously fight their way in opposite directions in the same steam-pipe. They could not. Another point to be remembered in regard to auxiliary steam-pipes was not to make them too large. A small pipe well lagged and protected at the flanges would give a much more satisfactory steam supply at the end of 100 ft. length than a badly drained unlagged pipe of twice the area, and in the case of the smaller pipe the steam velocity would keep the water moving and not allow the accumulation of those dangerous "slugs" which burst cylinder covers, broke piston rings, and generally damaged engines.

The reduction of noise and vibration in an engine-room was of the utmost importance, not only for the comfort, nerve-power, and endurance of those whose duties kept them there, but for the general success and character of the ship from a passengers' point of view, and he had often felt that the talent and skill displayed by the designers, supported by the ceaseless care of those in charge of the main engines to render them free from offensive vibration and knocking, was rendered futile by the abominable noise made by some small, under-sized centrifugal engine running beyond its proper speed, because, for the purposes of economy, its disc was too small to give the proper peripheral velocity without excessive speed. It was here that the advantages of the single-acting engine came in. The type of engine, originally made by one or two firms only, and non-compound and wasteful of steam, was now made as economical as any other type. Engines of that construction, made by a number of firms, ran with absolute silence. The author also referred to the arrangement of special pumping machinery, combined with ventilation, as fitted throughout the fleet of the "Shell" Transport and Trading Company. That system had been schemed out by Sir Fortescue Flannery and himself, and patented in their joint names.

COMING EVENTS.

October.

5th.—Society of Engineers: Meeting at the Royal United Service Institution, Whitehall, at 7.30 p.m.—South Staffordshire and East Worcestershire Institute of Mining Engineers: Annual Meeting at the University of Birmingham at 3 p.m.—Institution of Mechanical Engineers: Graduates Monthly Meeting at 7.30 p.m.

10th.—North of England Institute of Mining and Mechanical Engineers: General Meeting at Newcastle-on-Tyne at 2 p.m.—The Mining Institute of Scotland: General Meeting at Edinburgh.

12th.—Institute of Marine Engineers: Meeting at the London Institution at 7.30 p.m.

14th.—Institute of Marine Engineers: Annual Dinner at Liverpool Street Station Hotel.

16th.—Institution of Mechanical Engineers: Monthly Meeting.

26th.—National Free Labour Association: Eleventh Annual Congress at the Memorial Hall, London.

November.

2nd.—Institution of Mechanical Engineers: Graduates Monthly Meeting at 7.30 p.m.—Society of Engineers: Meeting at the Royal United Service Institution at 7.30 p.m.

SOME RECENT PUBLICATIONS.

"ELECTRICITY AS APPLIED TO MINING."

By Arnold Lupton, M.Inst.C.E., M.I.Mech.E., M.Inst. E.E., G. D. Aspinall Parr, M.Inst.E.E., A.M.I. Mech.E., and Herbert Perking, M.I.M.E. Crosby Lockwood and Son. 9s. net.

This is a type of book for which there should be a considerable demand. The domain of electricity has overlapped the work of the mining engineer to such an extent that a treatise intended to give the latter just those points in electrical engineering which he is likely to require in making new improvements, should meet with a hearty welcome among mining people. Some guarantee of its usefulness is to be found in the combination of forces indicated by the joint authorship, and its scope will be sufficiently indicated by the following synopsis of contents: Introductory—Dynamic Electricity—Driving of the Dynamo—The Steam Turbine—Distribution of Electrical Energy—Starting and Stopping Electrical Generators and Motors—Electric Cables—Central Electrical Plants—Electricity Applied to Pumping and Hauling—Electricity Applied to Coal-cutting—Typical Electric Plants Erected—Electric Lighting by Arc and Glow Lamps—Miscellaneous Applications of Electricity—Electricity as Compared with Other Modes of Transmitting Power—Dangers of Electricity.

"ELECTRICAL INFLUENCE MACHINES."

By John Gray, B.Sc. Second edition, revised and enlarged. Whittaker and Co. 5s. net.

The author remarks that since the first edition of this work was published the influence machine has shared in the general advance in electrotechnics. Its efficiency is still, however, very much below what is theoretically possible. Theoretically, the influence machine is equal in efficiency to the dynamo-electric machine, which has a practical efficiency of over 90 per cent. But, owing to leakage and faulty design, the practical efficiency of the influence machine is only about 5 to 10 per cent. There is evidently much room for improvement, and an attempt has been made in the present edition to indicate in what direction that improvement will take place. He has included descriptions of the latest machines which have proved successful in practice, and also a short account of the electronic theory.

"HEATING AND VENTILATION OF HOUSES."

Rural Handbook Series. Dawbarn and Ward, Ltd. 6d. net.

This little treatise discusses the principles involved in heating and ventilation of houses. Economy and existing conditions are first considerations, and a number of plans and diagrams serve to elucidate the author's suggestions.

"HINTS ON THE LEGAL DUTIES OF SHIP-MASTERS."

By Benedict W. Ginsburg, LL.D. Charles Griffin and Co.'s Nautical Series. Second edition, revised. 4s. 6d. Chas. Griffin and Co., Ltd.

This well-known manual is not designed to make every shipmaster his own lawyer, the author's aim being rather to provide him with an explanation in non-technical language of the principles upon which the law he has to obey is founded, and to give him some aid in the direction of his conduct when he is out of reach of other advisers. In this edition the text has been somewhat added to, and the latest rules and regulations are given in the appendices.

"THE MECHANICAL ENGINEER'S POCKET-BOOK OF TABLES, FORMULÆ, RULES, AND DATA."

A handy book of reference for daily use in engineering practice. By the late D. Kinnear Clark, M.Inst.C.E. Fifth edition, revised throughout and enlarged, by H. H. P. Powles, M.I.M.E., A.M.Inst.C.E. Crosby, Lockwood and Son. 6s. net.

The "get-up" of this useful little publication makes it pleasant to handle, and the pages place a wonderful amount of compressed information at the disposal of the mechanical engineer, the various tables being worked out in such detail that the pocket-book ranks as a time-saver of the first order. In addition to the indispensable mathematical tables of English weights and measures, with metric equivalents, many useful tables are given of the weights and strength of bars, sheets, beams, joists, girders, tubes, pipes bolts, and nuts, cylinders, nails, chains, and other manufactured pieces. On the strength of materials a variety of experimental evidence is given, with many new formulæ and tables. Heat and its applications have been fully considered in various aspects. The best proportions of steam engines, simple and compound, are discussed, together with pumping engines, water power, and compressed-air power. There is also a section devoted to electrical engineering.

"GRAPHICAL STATICS PROBLEMS."

By W. M. Baker, M.A. Edward Arnold. 2s. 6d. net.

Well arranged and issued at a reasonable price, this work embraces some 60 problems, and the student should find it a most useful auxiliary. Any problem when solved can be removed from the book, a perforation being provided for this purpose.

"ELECTRIC AND MAGNETIC CIRCUITS."

By Ellis H. Crapper, M.I.E.E. Edward Arnold 10s. 6d.

This volume, dealing with the fundamental principles of electricity and magnetism, and discussing the essential relationships of electric and magnetic circuits met with in continuous current working, is the first of a series of works on electrical engineering. These principles have been presented without assuming any previous knowledge on the part of the student. The author emphasises the importance of cultivating the ability to calculate readily and accurately, and has included a large number of valuable worked-out examples. Nearly 700 exercises to be worked out are also included, and form a special feature of the book, which is furnished with valuable appendices in the shape of logarithms and a general index.

OUR DIARY.

August.

22nd.—The trains on the Metropolitan District Railway to be worked on the Sprague-Thomson-Houston system of multiple unit train control.—The Engineering Standards Committee issue standard sections and specifications for tramway rails.—Death of Lord Salisbury.

24th.—Progressive Congress at Cape Colony has declared itself opposed to the introduction of Chinese labour.—Axminster and Lyme Regis Light Railway opens.—Japanese mails now being forwarded to Europe *via* Siberian Railway.—Mr. Marconi commences further experiments on the *Lucania, en route* for New York.—Launch of the new P. and O. steamer *Palma*.

25th.—Colonial Office Report on natives on Rand Mines showing abnormally high death rate.—Foreign Office issues report on the Economic Condition of Japan.—Board of Trade Report on Emigration and Immigration in 1902 published as a Parliamentary Paper.—The Commonwealth Senate at Melbourne passes the Naval Agreement Bill, providing for a contribution of £200,000 a year for ten years to the Imperial Navy.—Launch of the battleship *Dominion* at Barrow.

26th.—Report of the Commissioners of Customs for 1902-3 issued as a Blue-Book.

27th.—English Consul-General at St. Petersburg, in his report on Russian foreign trade for the past year, gives a gloomy account of the economic state of Russia. —Chinese Government opens Mukden and Ta-tung-kan to foreign trade.—The railway extension from Chamonix to Martigny in the Rhone valley has commenced. —Edinburgh tramway strike ended.

28th.—Amalgamation of shipping companies trading between the Tyne and Tees and London.—First meeting of the Carnegie Dunfermline Trust considers the directions in which the annual revenue of £25,000 may be applied.

29th.—Clyde shipbuilding returns show exceptional output for August, but prospects of the industry not bright.—New scheme issued for the reorganisation of bands for the Fleet.—Mr. Marconi arriving at New York, reports that the steamer was never out of communication with either Great Britain or America. —Mr. Ross Skinner, the Asiatic Labour Commissioner, leaves Southampton for South Africa.—Launch of the Russian battleship *Slava*.

31st.—Lock-out, Welsh tinplate trade, 16,000 men idle.—The Gloucestershire County Council Mining Scholarship of £100 for two years has been won by a working collier, named Sidney Thomas.—The Garden City Pioneer Company, Ltd., has acquired 4,000 acres of land near Hitchen for the first garden city.

September.

1st. £183,150 awarded by Sir J. W. Barry, as umpire, in the arbitration between the London County Council and the Metropolitan Electric Supply Company, Ltd., for the compulsory acquisition of the Company's generating works in Sardinia Street, Lincoln's Inn Fields, in connection with the Holborn to Strand improvements.—Serious dockfire at Limehouse Basin. —Notices served on men employed in Belfast Engineering Works, proposing a reduction of wages equal to 5 per cent.—Iron and Steel Institute Autumn Meeting opens at Barrow.—Successful trial trip of the new turbine steamer *Brighton*.

2nd.—Annual Meeting, Institution of Mining Engineers, Mr. O. C. Cadman being appointed President.—Congress on Technical Instruction opened at Belfast.

3rd.—Defeat of *Shamrock* in final run for the Cup.—Scotch Sanitary Congress opens at Stranraer.—Prospect of early settlement in the Welsh tinplate dispute.—Iron and Steel Meeting closes.

4th.—Experiments on the *Belleisle* to test corn pith cellulose for plugging—the vessel towed to bank.

5th. — German Shan-tung railway makes rapid progress, and is expected to be finished before June. —Commander Peary to start again for the North Pole in July.

7th.—Trade Union Congress at Leicester.—The Glamorganshire County Council Sanitary Committee is issuing special handbills to warn miners against ankylostomiasis, though, so far, no case has been discovered amongst the Welsh miners.

8th.—Work resumed in tinplate trade on old terms, pending reference to a joint committee.—The Bridge House Estates Committee of the City Corporation recommend the reconstruction of Southwark Bridge.

9th.—Seventy-third Annual meeting of the British Association opens at Southport.

10th.—Trade Union Congress passes resolution in favour of the legislative limitation of the hours of labour to eight per day, and of making this a test question at all elections; resolutions also agreed to with regard to the amendment of the Mines Regulation Act, etc.—Annual Conference of the National Association of Colliery Managers opens at Leeds.

11th.—Cunard Company reported to be entering upon a consideration of designs for the adoption of steam turbines in their new high-speed steamers.

12th.—Trade Union Congress closes—next year's Conference to be at Leeds.—Inspection of Naval College at Osborne, etc.

15th.—The *Times* officially informed that, subject to Parliamentary powers being obtained, a light railway is about to be constructed from the railway terminus at West Kirby across the Dee to Rhyl, Colwyn Bay, and Llandudno.

16th.—The British Association concludes its meetings at Southport.—Issue of Blue-Book on British and Foreign Trade and Industry.

17th.—Summary of wrecks in 1902, issued by Lloyd's.—Parliamentary Paper published on Uganda Railway.—Board of Trade Return issued on trade between the United Kingdom, Canada and Germany. Mr. Stanley Spencer tests his air-ship over London.

18th.—Parliamentary Paper on trade and general conditions of the British Central Africa Protectorate for 1902-1903. — Newcastle-on-Tyne City Council adopts scheme for improving and extending the river quay at a cost of £559,000.

21st.—Further experiments on the electric railway at Zossen reported to have resulted in a speed of nearly 114 miles an hour being attained.

THE REDUCTION OF POWER LEAKAGES BY SELF-SETTING PACKING.

DESPITE a concentration of the inventive faculty upon the question of efficient engine packing, leaking glands remain a common source of trouble in the engine room, while it is to be feared that the amount of energy wasted by unnecessary friction in this direction must reach an enormous aggregate in the course of a year. We are inclined to think that the ideal packing has yet to be produced, but in the meantime every effort that is made in the direction of reducing unavoidable friction in packing piston rods merits the careful attention of engineers. We illustrate herewith a form of highly elastic self-lubricating packing which is very widely used in the United States, and is being introduced over here by Messrs. Ronald Trist and Co., of the Quaker City Rubber Company of Philadelphia, U.S.A.

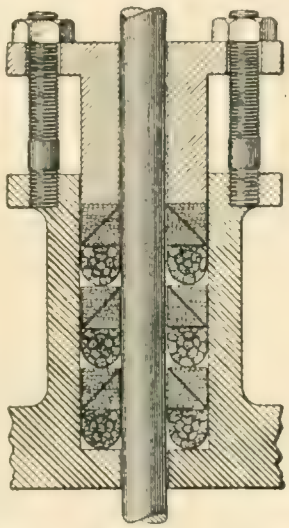

FIG. 1. POSITION OF PACKING WHEN FIRST APPLIED.

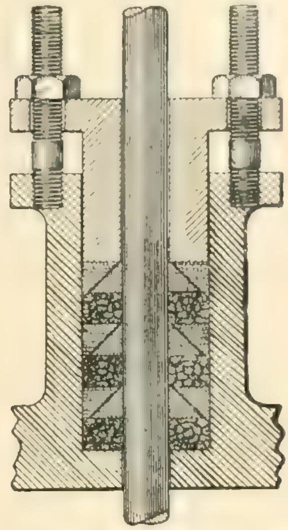

FIG. 2. POSITION OF PACKING AND WEDGES IN CONDENSING ENGINE.

Advocates of metallic packing are often ready to admit that soft packings may be satisfactory for a time, but they urge that when the rods wear down on the bushes, the glands require screwing up very tightly to prevent the escape of steam, considerable friction being the result; while, in addition, the frequent renewal of the packing is necessitated. The new "P.P.P." packing is designed to produce exactly the opposite results, its prominent characteristics, as vouched for by users, being long life and reduced friction on the rod. It is adjusted automatically by the pressure against which it is required to be tight, thus obviating fixed pressure and consequent unnecessary friction. Frequent re-packings are also avoided, for less friction, of course, means less wear of packing. This is a very important point. As the packing wears gradually away, all that is required is the occasional addition of a new ring. Moreover, the packing adjusts itself to the varying pressure throughout the stroke of the piston. As will be seen from the accompanying illustrations, it is composed of two wedges and a yielding absorbent cushion. The wedges are made of material that will stand wear, and so shaped that from pressure of steam in the stuffing-box, they will freely slide on each other, compensating for the wear made by the rod, or inequalities of the rod or box. The cushion absorbs oil that may be put on the rod, or fed to the box by other means, letting it down to the rod evenly and regularly—the combination making a soft but very elastic packing, and, when properly applied, preventing the rod from binding or heating. The packing is prepared with special lubricants which enamel the rod, filling in the scores, if any, and ensuring easy running. A series of tests of the best grades of fibrous packings compared with Daniel's "P.P.P." packing made by Professor H. W. Spangler, Professor of Mechanical Engineering in the University of Pennsylvania and others, showed that the solid packings or those not self-setting, increased the friction on the rods so that it required from 2·31 to 7·27 more horse-power to maintain the same piston travel, on a given engine, while the increased friction on the rod of the solid packing ranged from 11·62 per cent. to 59 per cent. The money value of power saved by the use of Daniel's "P.P.P." packing, as shown by these tests, ranged from £20 16s. to £50 per rod per annum, while the solid packings exceeded "P.P.P." in cost from 80 to 240 per cent. for a like period. Among other advantages it is claimed for the packing that it is elastic, self-lubricating, light, impervious to the action of steam, oils, acids, alkalies, and sulphurous waters, can be used with super-heated steam or the extreme low temperatures met with in refrigerating machinery, and is equally adapted for the hydraulic elevator or the air-pump. It is claimed that the gland is never the medium through which pressure is applied to this packing—it remaining loose and free to move in a direction parallel to the rod. A considerable amount of friction is avoided, as virtually the packing has the mere pressure of contact only, except at such periods of the stroke as when there is a pressure exerted in the cylinder, this same pressure being the *vade mecum* by which a joint is made on the rod. It should pay steam users to investigate these claims for themselves.

NEW CATALOGUES & TRADE PUBLICATIONS.

The Thornycroft Steam Wagon Company, Ltd., Homefield, Chiswick, London, W.—Section A of the second edition of this firm's catalogue is a neat little brochure of 32 pages and cover, the latter of bas-relief model design. It comprises a brief introduction, followed by a short description of the many uses to which their steam wagons have been adapted by customers, and an "Honours List," which includes highest awards at the Crystal Palace, 1896; Richmond, 1899; Dover, 1899; Liverpool, 1899 (two); Liverpool, 1901 (two); also the First Prize (£500) in the War Office Competition, December, 1901. Then follows a general description of the different types of vehicles manufactured by the firm, in which connection it is interesting to note that in general a form of water-tube boiler (specially designed and patented by themselves) is employed for their steam wagons. There is also an interesting reprint (with illustrations) from the *Engineer*, giving an excellent description of the Company's Basingstoke works.

The British Thomson-Houston Company, Ltd., Rugby.—Pamphlet No. 142, of 12 pages (superseding No. 123), comprises an illustrated description of continuous and alternating current fan motors of several designs for desk, bracket, and ceiling, and voltages from 55 to 250; also exhaust fans, a small and compact line of which we understand this company has lately introduced. These are being largely used for ventilating purposes in private residences and apartments as well as in public buildings and offices. A 4-page illustrated pamphlet (No. 143) deals with the "C R" Feeder Regulator. This is of the transformer type, having its primary connected across the bus bars, and its secondary wound in several sections controlled by a dial switch, the windings being arranged similarly to those of the Type "H" Transformer.

The Library Supply Company, 181, Queen Victoria Street, E.C.—This is a well-designed, illustrated booklet of 60 pages and cover, dealing with the card system and its applications, including a price list of card cabinets, letter-filing cabinets, cards, and supplies. The system, it is claimed, enables the business man to "organise, classify, and subdue his records, transforming them into a veritable nerve system of his business, as responsive to every call for information as are the nerves of the body to every sensation." It can be applied with great advantage in factory-cost keeping, and a few drawings of the more important cards used for this purpose by engineers are reproduced. It has also been adopted by many firms for ledger accounts, and, we are told, is a great improvement over the book ledger for posting, account making, getting out balances, and following up overdue accounts.

The Brush Electrical Engineering Company, Ltd., of London and Loughborough.—"Bulletin No. 3" is a sixteen-page illustrated booklet of excellent design, entitled "Trucks." The following types are fully described and illustrated: Type A—The Single Truck, which, it is claimed combines all the improvements which go to make an easy riding, perfect curving, safe and economical truck. Type B—The Maximum Traction Truck. This is of solid steel, is composed of very few parts, and has a fixed radiating point, swinging bolster and centre bearing. Type BB—Similar to Type B, but adapted to carry larger car bodies and is of heavier construction throughout. Type D—The Equal-Wheel Bogie Truck. Can be made for either one or two motors, and where car bodies can be built wide enough to permit the radiation of the wheels between the sole bars, it is considered the best type of truck to use. Type E—The Four-Wheeled Bogie Trail Truck. Designed for high-class service and has fewer parts than any other of its kind. Type F—The Heavy Service Motor Truck. This is used on many of the elevated electric railways in the U.S.A., and we understand has also been adopted by the Metropolitan District Railway of London as their standard. It is built in three different weights—for light railways, main line rolling stock, and for heavy electric locomotives up to 150 tons. A useful list giving prices and specifications of the various types appears at the end of the book.

Holden and Brooke, Ltd., West Gorton, Manchester.—List No. 45 is a neat little brochure of eighteen pages and cover illustrating and describing water separators or "steam dryers" for extracting water or grit from either high-pressure or low-pressure steam. It includes a short treatise on "wet steam" and the troubles resulting therefrom, with a necessarily interested but most effective suggestion for their prevention—efficient separators. List No. 46 is a similar pamphlet entitled "Oil Separators," dealing principally with Brooke's patent oil separator, which is designed for the extraction of liquid and semi-liquid oil from exhaust steam, and, it is claimed, is equally applicable and effective under the conditions of either condensing or non-condensing plants. List No. 47 is a twelve page illustrated booklet dealing with Brooke's patent automatic grease discharger or vacuum trap, being a device for discharging grease, oil, and condensation water from pipes and chambers under vacuum, and, if required, may be arranged to force its discharge to a considerably higher level than itself. The auto-discharger is simply connected to the separator by two pipes, and is in working order immediately; and it is claimed that there is nothing in the construction of the apparatus which can possibly get out of order. A four-page leaflet describes the "Sirius" One-Movement Injector (Pattern "S") for feeding any class of boiler, and at any pressure up to 300 lb. per square inch. Illustrations of other patterns also appear.

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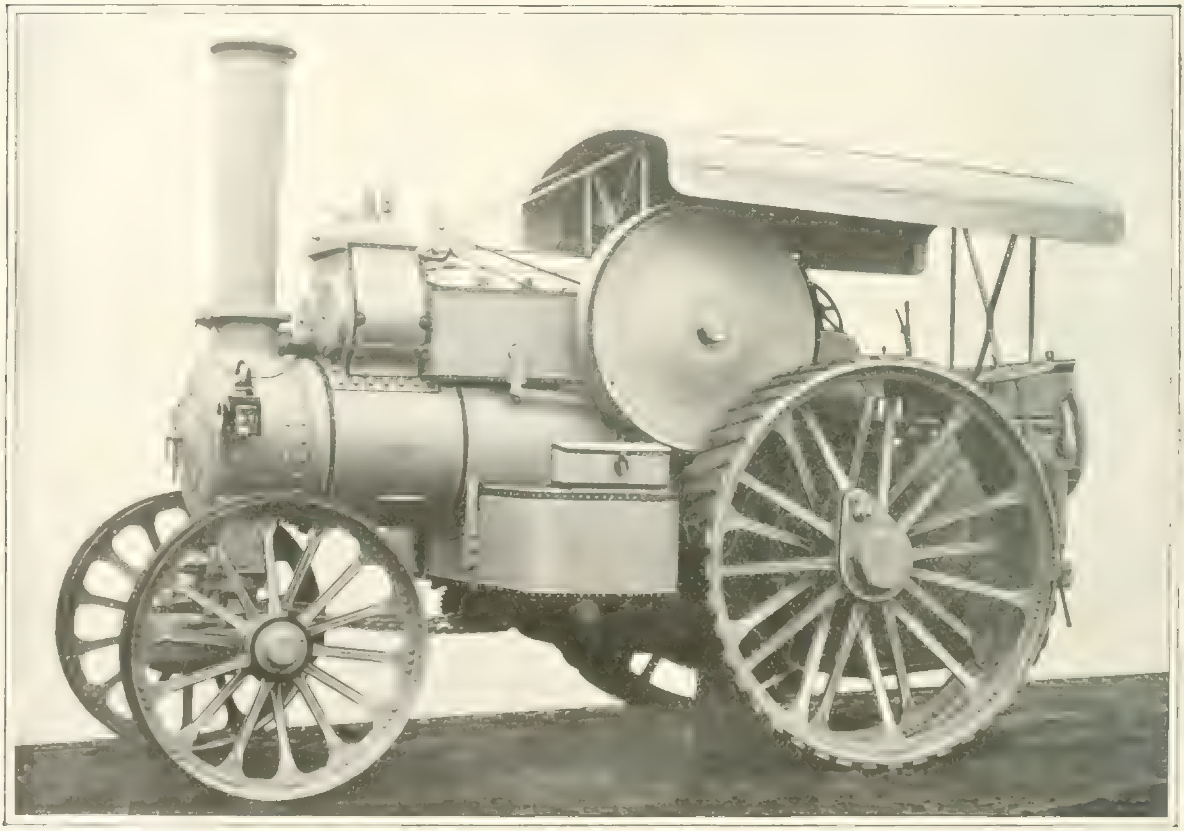

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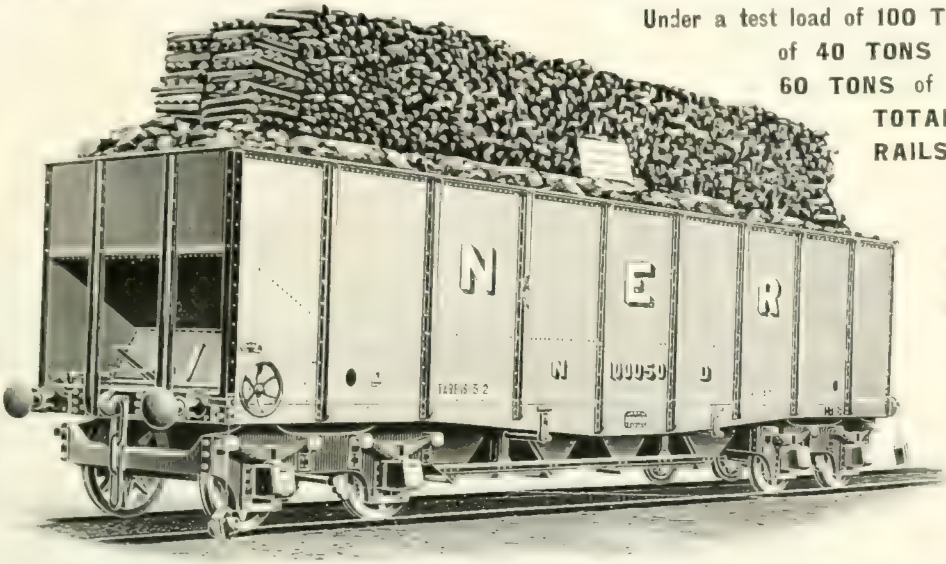

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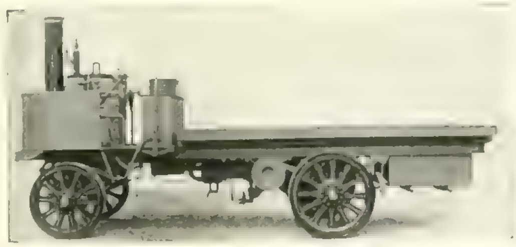

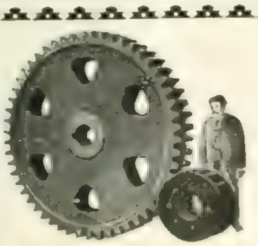

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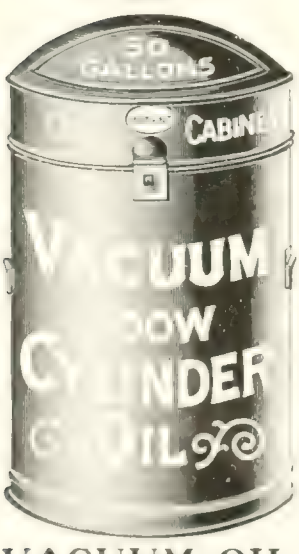

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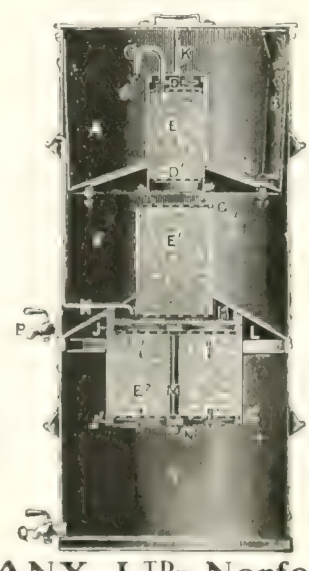

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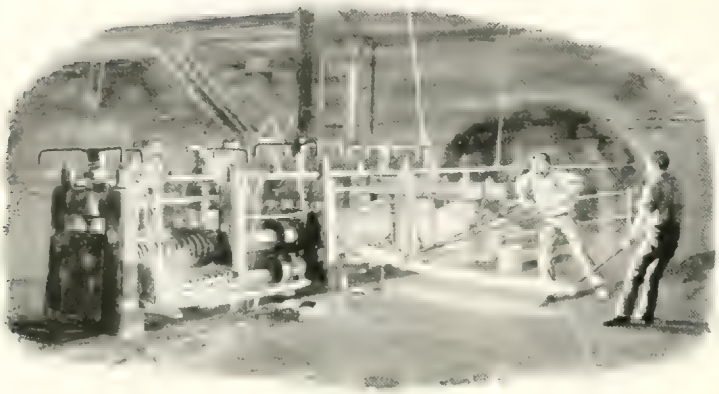

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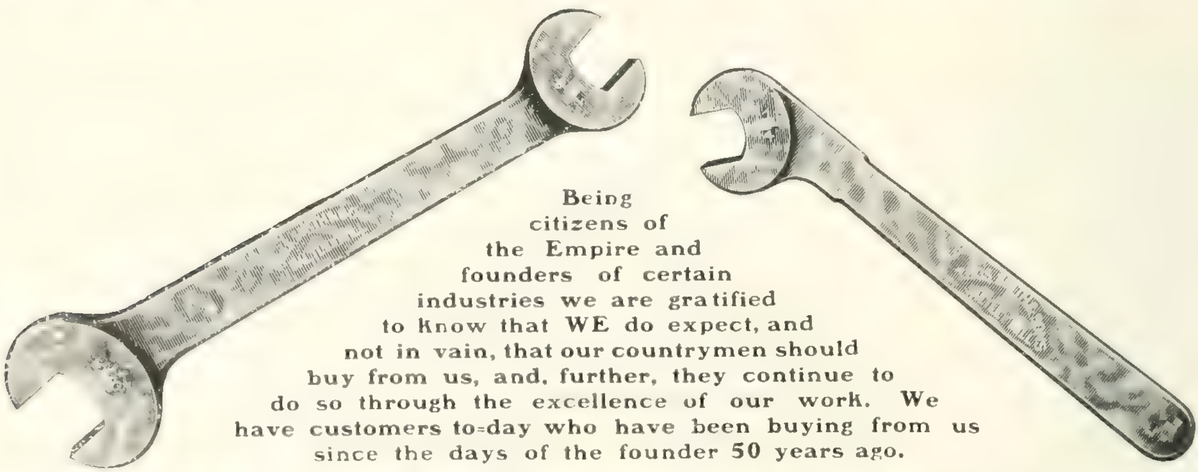

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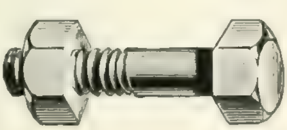

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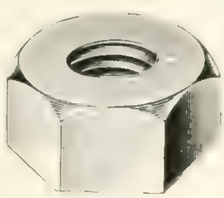

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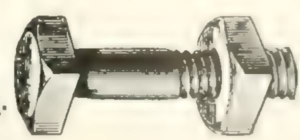

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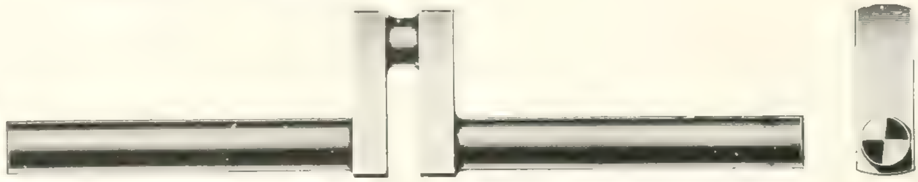

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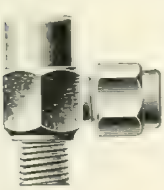
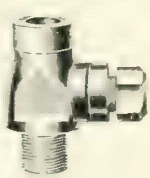

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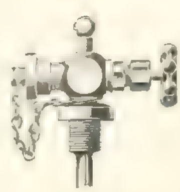

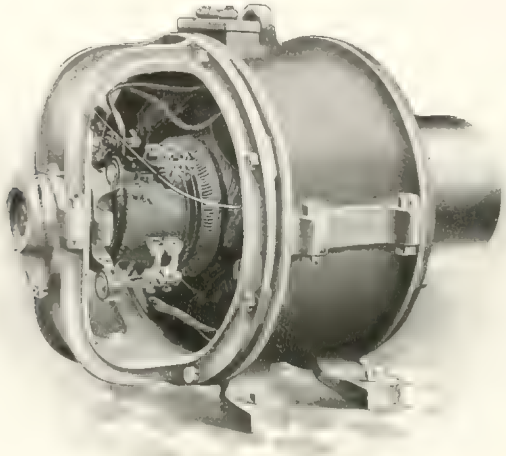

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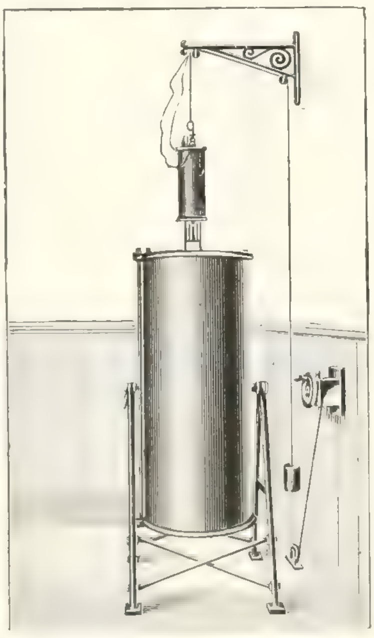

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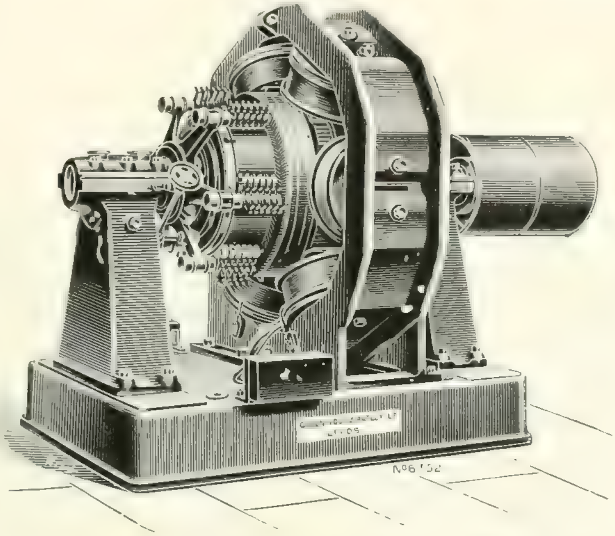

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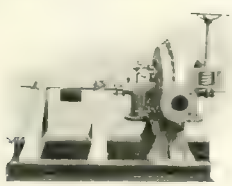

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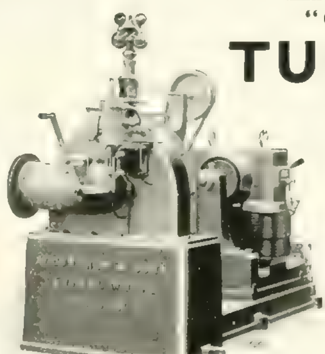

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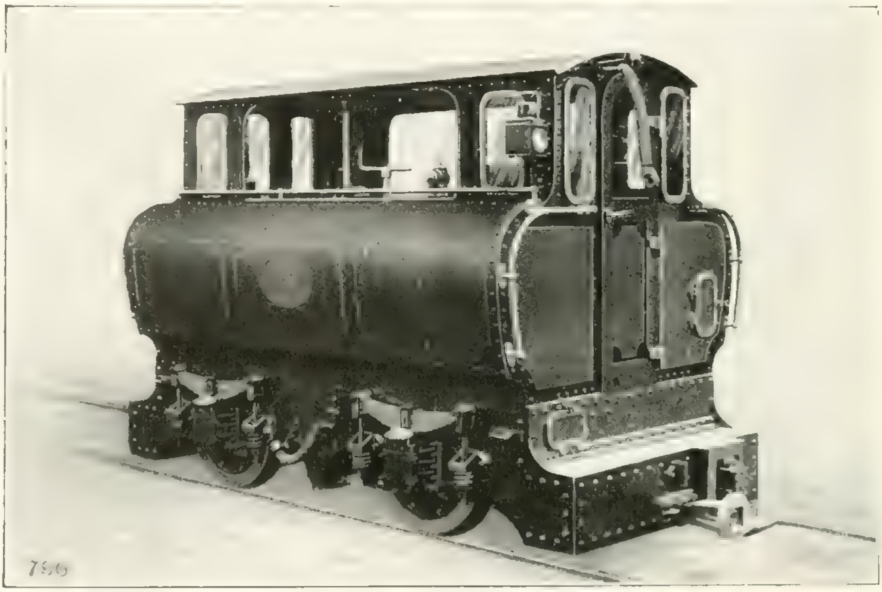

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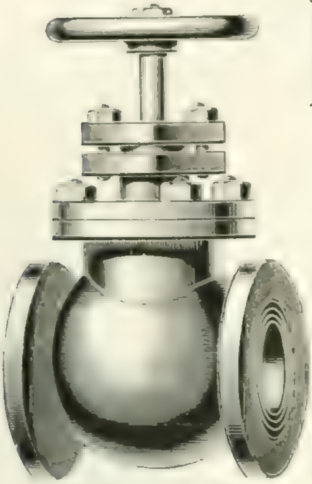

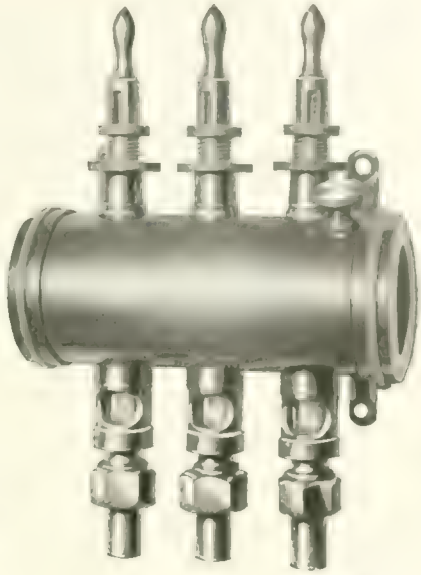

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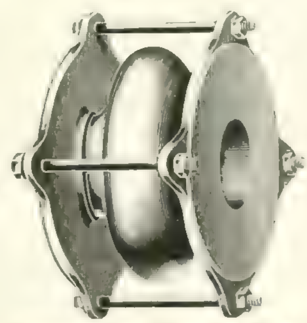

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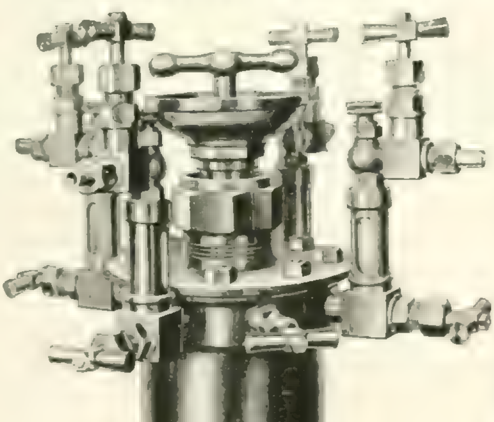

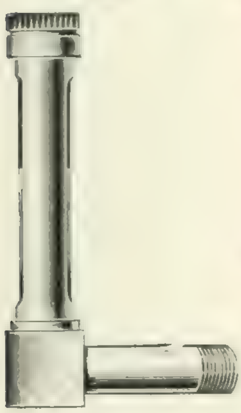

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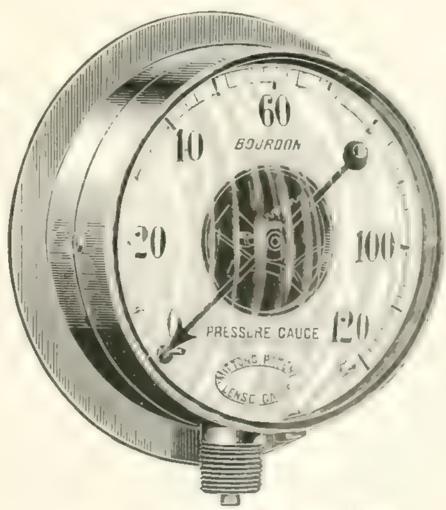

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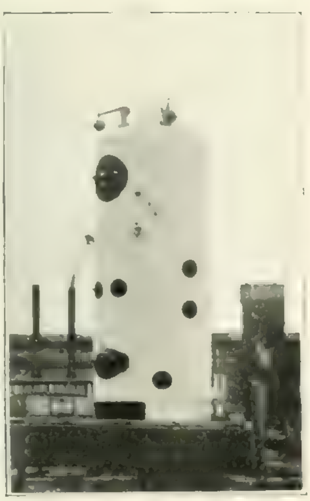

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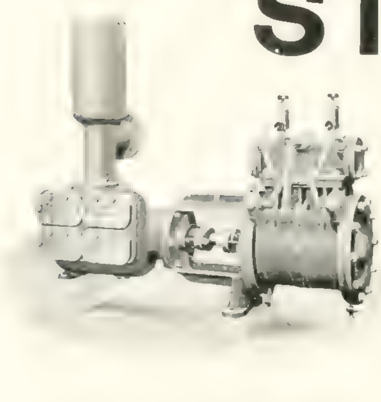

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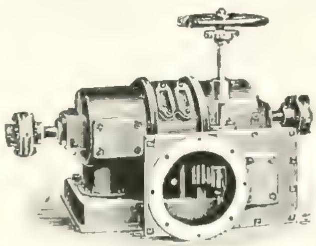

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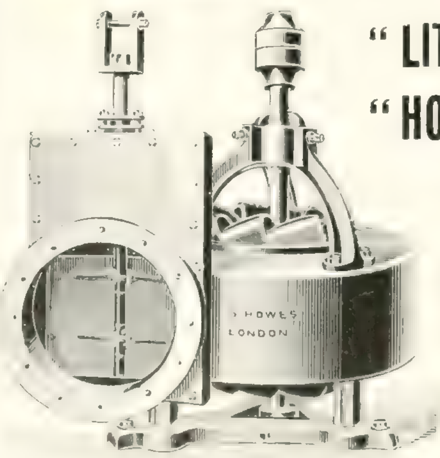

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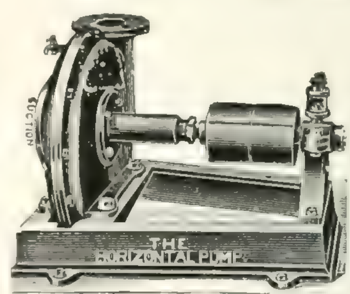

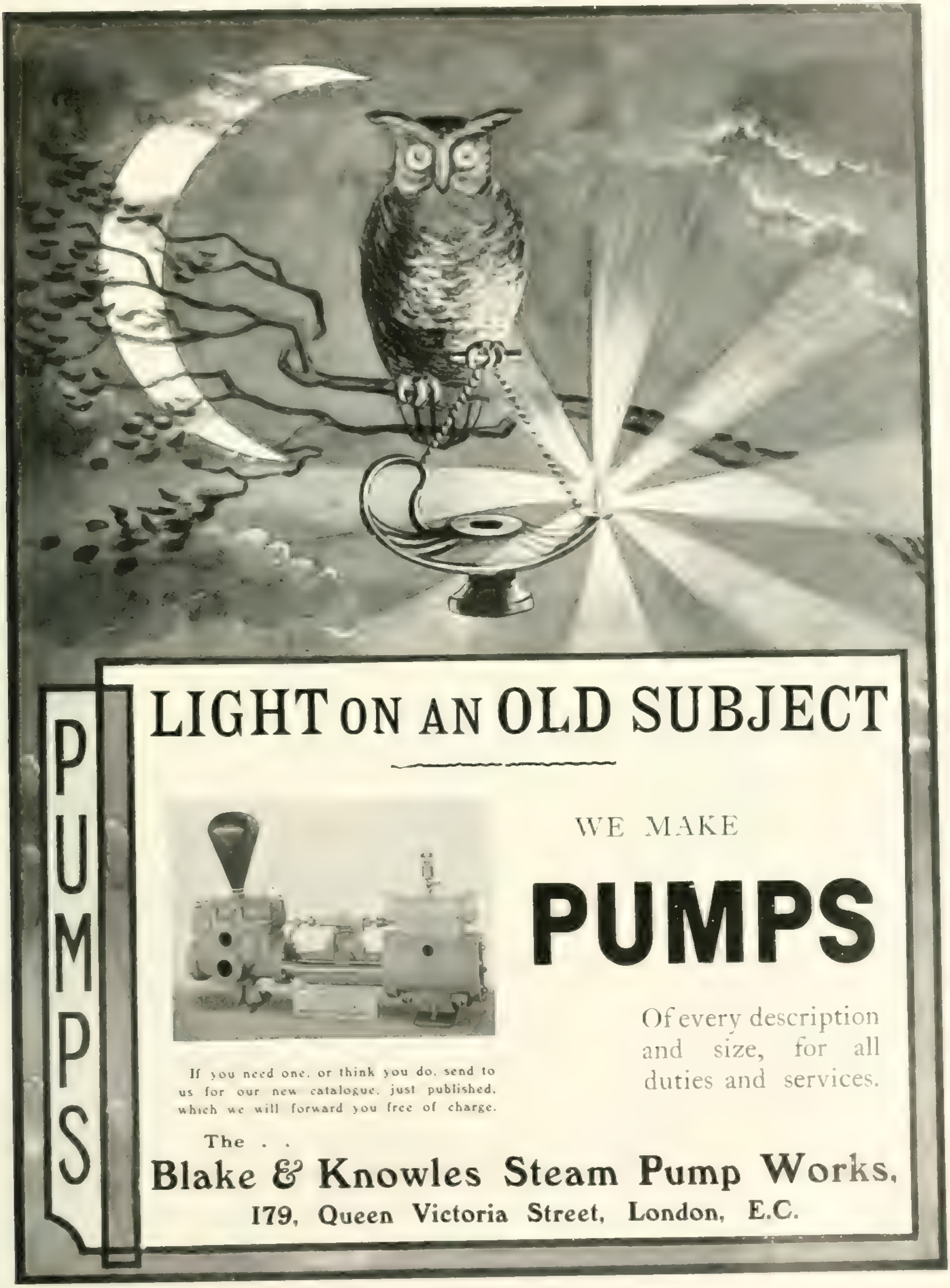
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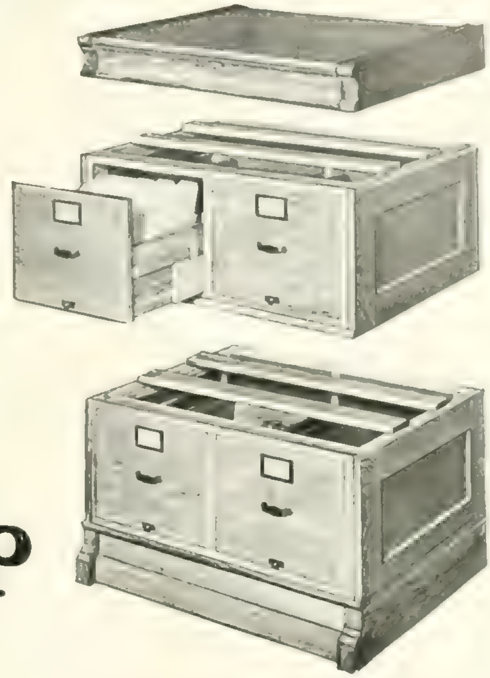

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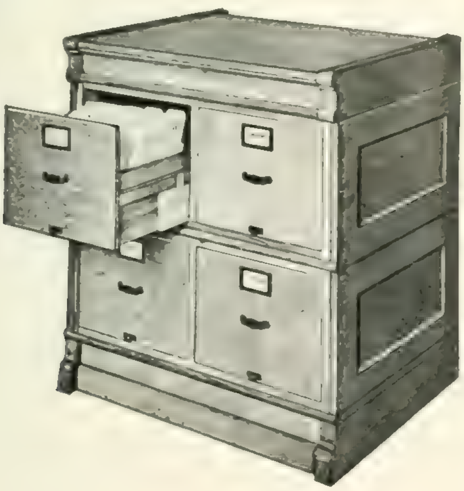

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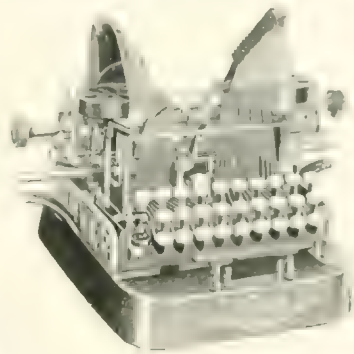

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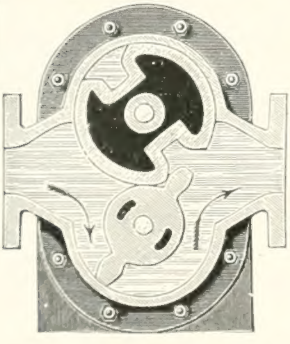

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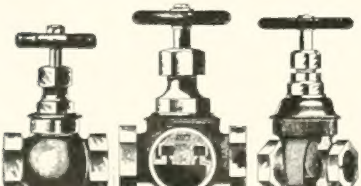

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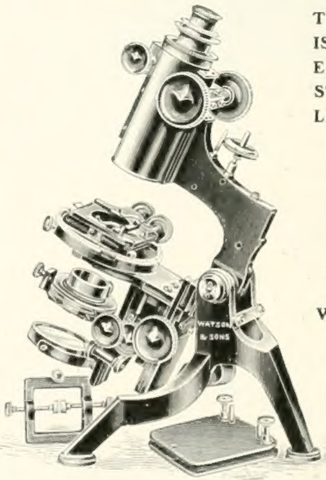

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